



Government of Gujarat

GUJARAT FERTILISER PRODUCTION COMMITTEE



FERTILISER PROJECT FOR GUJARAT
(CAPACITY 96,000 TONS NITROGEN PER YEAR)

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INTRODUCTION

CONSTITUTION AND TERMS OF REFERENCE OF THE FERTILISER COMMITTEE

On 14th May 1960 and 23rd May 1960, Government of the Gujarat State, Ahmedabad, constituted the Gujarat Fertiliser Committee, by resolutions Nos. IND-1060-F, and IND-1060-F, respectively of the Law and Industries Department. The relevant portion of the resolutions is reproduced below :—

“ In view of the importance of encouraging production of nitrogenous fertilisers as a means of increasing food production the Government considers it necessary to explore ways and means of setting up one or more units of production of nitrogenous fertilisers in the State. The Government of India have indicated the need for additional units of production as also for locating them in different parts of the country.

2. The Government of Gujarat has, therefore, decided to constitute the following Committee to consider this matter and submit recommendations on the various problems involved :—

- (1) Shri V. Isvaran, I. C. S.,
Chief Secretary to
Government of Gujarat . . . Chairman.
- (2) Shri M. G. Monani, I. C. S., Secretary,
Legal and Industries Department.
- (3) Dr. Bhatt L. A.
- (4) Dr. Parekh M. D.
- (5) Dr. Trivedi R. K.
- (6) Dr. Patel C. B.
Director of Industries,
Gujarat State (who will work as Secretary of the Committee).

3. The following are the terms of reference of the Committee :—

- (i) To consider and indicate the (a) most suitable locations for establishing nitrogenous fertiliser plants in Gujarat ; (b) types of fertilisers to be manufactured ; (c) capacity of the plants ; and (d) raw materials to be used,
- (ii) To estimate the capital and working costs of the plants for the production units recommended,
- (iii) To estimate and report the requirements of technical personnel for each of the production units recommended,
- (iv) To suggest the best method of further processing the Committee's recommendations.

4. The Committee will submit its report to the Government within a period of two months.”

The Committee held its meetings on the dates given below :—

1. 24th May 1960 at Ahmedabad.
2. 30th May 1960 at Bombay.
3. 25th June 1960 at Bombay.
4. 1st August 1960 at Ahmedabad.

The Committee also visited the following places on the dates shown against them to make an on-the-spot study of the facilities available at each of these locations. The observations will be discussed at appropriate places subsequently in the report.

1. Cambay, 10th July 1960.
2. Broach, 23rd July 1960.
3. Bhavnagar, 30th and 31st July 1960.

The Committee places on record their appreciation of the information supplied by various Government Officers concerned and by private citizens whose knowledge of local conditions and whose experience proved a valuable guide to the members of the Committee.



CHAPTER I

HISTORICAL REVIEW OF THE FERTILISER INDUSTRY IN INDIA

1.1. The acute food shortage problems which prevailed prior to independence has aggravated in subsequent years. This led the Government of India to give top-priority to agricultural production in the First Five-Year Plan. At the same time, it was felt that intensive cultivation and greater use of fertilisers was necessary for increasing agricultural production. Prior to the last World War (1939-1945) Indian Consumption of inorganic fertilisers consisted of ammonium sulphate. In the year 1938-39, one lakh ton ammonium sulphate was used, mainly by plantations in South India. Annually about 20,000 tons were produced as a by-product of coal-coking industry. About 5,000 tons were manufactured by the only synthetic unit at Mysore and the rest was imported.

After the war, the then Travancore Government assisted in establishing production of ammonium sulphate at Alwayee near Cochin. A land mark in the history of fertiliser development was the setting up of a large State-owned fertiliser factory at Sindri (Bihar) with an installed capacity of 3,50,000 tons of ammonium sulphate (equivalent to approximate 70,000 tons of nitrogen) per annum ; this production materialised in 1951. The total Indian installed capacity of ammonium sulphate rose from 81,000 tons in 1950 to 4,31,000 in 1958. The beginning of the First Plan was thus really the starting point for the rapid growth of fertiliser production. Consumption of ammonium sulphate from 1951 to 1958 also showed a steady rise as indicated in the graph (please refer to Appendix I).

Ammonium sulphate was the only nitrogenous fertiliser that was manufactured so far. A small quantity of ammonium chloride was manufactured in South India, but almost the whole quantity was consumed by industries. Some quantity of imported sodium nitrate was utilised for agricultural purposes. Trials of urea, nitro-chalk, ammonium chloride and ammonium nitrate sulphate mixtures were being taken by importing these items under T. C. M. programme.

Ammonium sulphate has been considered a popular fertiliser in India as it is suitable for all types of soils except acid soils. Further, viewed from climatic conditions ammonium sulphate is considered a very suitable fertiliser for areas of high humidity, as in such atmosphere it has the most satisfactory keeping and free flowing quality. As regards ease of application, handling and freedom from hazards, ammonium sulphate scores over every other type of nitrogenous fertilisers under the existing pattern of development of our agricultural practices. However, looking to the cost of production and economy in transport, ammonium sulphate is expensive type of nitrogenous fertiliser, definitely more expensive than ammonium nitrate and urea, the latter being the cheapest in production cost as also transport cost as compared to other nitrogenous fertilisers.

Consequently, other nitrogenous fertilisers were tested fairly extensively all over the Indian continent and it was established that these nitrogenous fertilisers (other than ammonium sulphate) were comparable in efficiency to ammonium sulphate. These aspects seem to have been kept in view at the time of drafting the programme for setting up new fertiliser factories during the course of Second Five-Year Plan,

1.2. The capacities for production of nitrogenous fertilisers in existing factories as well as those under expansion and new projects under implementations are given below :—

TABLE I

Project	Type of nitrogenous fertilisers		Annual capacity in tons nitrogen per year	Expected date of implementation
1. Expansion of Sindri fertilisers.	(a) 400 tons per day of double salt. (b) 70 tons per day of urea	}	47,000	Middle of 1959.
2. Nangal fertilisers	.. Ammonium nitrate ..	..	70,000 80,000	Third or Fourth quarter 1960.
3. Rourkela fertilisers	.. Nitro-limestone ..	..	80,000 1,00,000	End of 1961.
4. Expansion of FACT Alwayee.	(a) Ammonium sulphate (b) Ammonium phosphate	}	10,000	Early 1960.
5. Neyveli fertilisers	.. Urea ..	..	70,000	End of 1962.
6. Sahu Chemicals, Varanasi	.. Ammonium chloride (By-product).		10,000	End of 1959.
Capacity in existence (in terms of nitrogen)			.. ..	2,87,000/3,17,000 85,000
Total capacity in terms of nitrogen			..	3,72,000/4,02,000

It will be observed from the above Table that for the first time a programme has been envisaged for the manufacture of ammonium chloride as a by-product fertiliser. The above figures though they indicate a substantial increase in capacity, are not considered adequate for the heavy demand of the country. The Development Council for acids and fertilisers and other organisations keenly interested in the use of fertilisers have been pressing for higher targets for production in the Third Five-Year Plan as an important step towards the attainment of the goal of self sufficiency in food grains as also cash crops. Consequently, the Ministry of Food and Agriculture after due consultations have agreed to the setting up of a capacity (for planning production) at one million tons of nitrogen per year by 1965-66.

Suggestions have already been made that in relation to our food problems, even a target of one million tons of nitrogen per year might turn out to be too low and that it would be worthwhile to raise it to at least 1.5 million tons.

Even with a target of one million tons of nitrogen, there is still a considerable gap between this target and the total projected capacity as indicated in Table I. In short, there will be a big gap between actual production and the requirements. It is, therefore, imperative that planning for setting up of fertiliser plants in various States during the Third Five-Year Plan should be undertaken immediately. In this connection, spokesman of the Government of India have already indicated the need for additional nitrogenous fertiliser units in each State of the Union.

1.3. Gujarat's position in regard to production of foodgrains is well-known. It is highly deficit in foodgrains and as a result, the Government have been launching a number of irrigation schemes with a view to increasing food production. But along with water, adequate quantity of fertilisers have also to be made available. With this aim in view, Gujarat Government have considered it necessary to explore ways and means of setting up one or more units for production of nitrogenous fertilisers in the State.

CHAPTER II

GUJARAT'S REQUIREMENTS OF NITROGENOUS FERTILISERS : CONSIDERATIONS OF UNIT SIZE

2.1. General.—Gujarat is not self-sufficient with regard to foodgrains. The population is growing very rapidly and the vagaries of nature make our agricultural production unpredictable. In order to make up this deficit, Government have launched a number of irrigation schemes in almost all the districts of Gujarat. Thus a large area of land will come under irrigation in the near future. Farmers have been using from time immemorial farm yard manure, groundnut cake and leguminous crops as sources of organic fertilisers on their lands. These sources are now falling short of the requirements especially in view of better irrigational facilities. So far as Gujarat is concerned, we have two industrial units engaged in the manufacture of single super-phosphate as source of phosphatic fertilisers. Two more licences have also been granted to two entrepreneurs for the manufacture of this type of fertiliser. There is, however, not a single nitrogenous fertiliser manufacturing unit in this State. The requirement of nitrogenous fertilisers is presently met by imports from Sindri unit and other sources.

2.2. Characteristics of soils in the State of Gujarat.—The soils of Gujarat can be broadly classified into five main groups (i) shallow residual soil, (ii) medium black soil, (iii) deep black soil, (iv) sandy loam (Gorat or Goradu), and coastal alluvium. Analytical results available for about fifteen sites are given in Appendix II.

The soils of northern-most districts are predominantly sandy, containing fairly large amounts of coarse sand. They are deficient in organic matter and nitrogen and respond well to manuring and irrigation.

Two types of soils occur in the Ahmedabad district : black soil and goradu soil. The black soil of the district is not very clayey. It contains about 20 per cent. of clay and about 40 per cent. of sand. The goradu soils are rich loams and respond very well to irrigation and manuring.

The soils of Kaira district are sub-divided into four main groups by the local agriculturists. They are (i) Goradu, (ii) Besar, (iii) Black and (iv) Bhatha soils.

The soils of the Panchmahals are stoney or gravelly, shallow, light coloured and invariably of low fertility.

In the Baroda district, two types of soils are met with. They are (i) Black and (ii) Gorat. The Gorat soils are low in organic matter and nitrogen. The black soils truly speaking are usually medium black soils. These soils are usually poor in plant nutrients. They contain 0.03-0.4 per cent. nitrogen and 0.02-0.2 per cent. potash.

The Broach and Surat district form the southern part of Gujarat and the soils in both these districts are predominantly black cotton soils. The amount of phosphoric acid nitrogen and organic matter is, however, frequently low.

Two typical analysis from Saurashtra are given in Appendix II; Amreli and Dwarka. The first represents soils met with on the plains and a variety of medium black soil. It is the typical agricultural soil in Saurashtra. In the hilly parts the soils are, however, shallow and often gravelly. The soil met with along the coastal line of Saurashtra is represented by the sample from Dwarka. These soils are poor in organic matter and nitrogen.

The soils of Kutch are shallow and stoney and are generally poor in nitrogen and fair in phosphoric acid and potash content.

It may be generally stated that almost all soils are deficient in 'Nitrogen' and that they respond to 'Nitrogen' application.

2.3. Acreage of land under cultivation covering various crops in Gujarat.—From the following table No. II it will be seen that a total area of 14.88 lakh acres is irrigated in the State. This amounts to almost 6.0 per cent. of the total area of the State under cultivation against each crop.

TABLE II

Serial No.	Name of the crop			Total area in acres 1956/1957	Irrigated area in acres 1956/1957
1	2	3	4	5	6
1	Rice ..	..	..	13,47,100	1,60,900
2	Wheat ..	..	..	13,28,500	5,04,200
3	Jower ..	..	..	35,21,500	65,700
4	Bajri ..	..	..	41,11,100	81,300
5	Pulses ..	..	..	16,44,200	..
6	Other food crops ..	..	..	10,70,900	2,63,100
7	Cotton	..	..	45,36,600	1,10,200
8	Tobacco	..	..	1,89,900	21,700
9	Groundnut	..	..	30,81,400	8,500
10	Sugarcane	..	..	39,200	39,200
11	Miscellaneous crops	..	..	31,09,600	2,33,600
			Total ..	2,39,80,000	14,88,400

2.4. Area of land under cultivation where there is assured rain-fall.—The area of land under cultivation where there is assured rain-fall is given below. Thus it will be seen that about 19 per cent. of the total area gets assured rain-fall during the year.

TABLE III

Serial No.	District	Net area sown in acres	C. fallows in acres	Other fallows in acres	Total area in acres
1	2	3	4	5	6
1	Surat ..	16,73,700	20,600	40,900	17,35,200
2	Dangs ..	51,500	19,200	..	70,700
3	Bhavnagar ..	10,97,100	9,700	20,700	11,27,500
4	Junagadh ..	14,80,800	82,400	1,17,600	16,60,800
Total ..		43,03,100	1,31,900	1,79,200	45,94,200

2.5. Present consumption of nitrogenous fertilisers and the nature of fertilisers used.—Consumption of fertilisers during the last 3 years is given below :—

TABLE IV

Serial No. 1	Name of the fertiliser 2	Consumption of fertilisers			In terms of nitrogen 6
		1957/58 3	1958/59 4	1959/60 5	
1	Ammonium sulphate ..	tons 20,400	tons 14,461	tons 19,558	tons 4,113
2	Calcium ammonium nitrate ..	..	235	163	375
3	Ammonium sulphate nitrate ..	3,800	4,216	4,705	1,223
4	Urea	492	521	4,080	1,876
	Total, nitrogenous fertilisers ..	24,692	19,433	28,506	7,587

This cannot, however, be taken as an index of actual requirements, because due to scarcity of fertilisers, supplies to States have been made on the basis of previous consumption. Scarcity in indigenous production and foreign exchange shortage involving restricted imports are responsible for reduced consumption of fertilisers in India. Some indications of increasing demand can be had from the quantities of different types of nitrogenous fertilisers indented by the Agricultural Department for the year 1961-62. These figures are given below :—

TABLE V

Serial No. 1	Name of the fertiliser 2	Quantity of fertilisers indented by the Agricultural Department for 1961/62 (in tons)		In terms of nitrogen (in tons) 4
		3	4	
1	Ammonium sulphate ..	..	..	9,640
2	Calcium Ammonium nitrate ..	..	8,328	1,915
3	Ammonium sulphate nitrate ..	..	13,847	2,600
4	Urea .. ..	..	8,677	4,000
	Total ..	76,765		18,155

In the past, agriculturists were not fully aware of the advantages of nitrogenous fertilisers in soil and consequently the consumption of such fertilisers was quite low. In recent years considerable consciousness about the value of fertilisers has been aroused amongst the cultivators in this State and it may be safely assumed that consumption will increase very considerably if supplies could be enhanced.

Consumption of fertilisers, both nitrogenous and phosphatic, would increase considerably in future and the supply position is not likely to catch up with the demands even though the expansion schemes as stated in Chapter I are implemented. This accelerated progress in fertiliser consumption deserves highest priority for the Nation as :—

(1) Gujarat must wipe out the present deficit for foodgrains.

(2) Gujarat must also provide food for increasing population and better standard of living.

(3) Gujarat must look for increased yields of cash crop to provide raw materials for its existing industries such as Textile, Sugar, etc.

There is, therefore, an urgent need for setting up nitrogenous fertilisers manufacturing units at suitable centres in Gujarat.

2.6. Estimate of requirement of nitrogenous fertilisers.—In Gujarat the total land acreage under cultivation would be about 8 per cent. of the entire land under cultivation in the whole country. It would, therefore, be valid to start with an assumption that the requirements of nitrogenous fertilisers in Gujarat would be almost 8 per cent. of the total Indian target set for these fertilisers. Starting on this basis, requirement of nitrogenous fertilisers in Gujarat would be of the order of 1,20,000 tons of nitrogen per year, on the basis of the total Indian demand of 1.5 million tons Nitrogen by the end of Third Five-Year Plan.

However, to be more precise on this issue, it is considered necessary to have some idea about the possible change in the cropping pattern of the State with a view to estimating the requirement of different types of fertilisers at the end of the Third and Fourth Plans. In the light of the additional irrigation facilities that may be available during these plans and assuming that the percentage of irrigated area out of the total cultivated area will be about 10 per cent. and 14 per cent. at the end of Third and Fourth Plan periods respectively, the cropping pattern should be tentatively as follows, if maximum utilisation of irrigation facilities is to be assured :—

TABLE VI

(Area in lakh acres)

Serial No.	Crops	Distribution of crops in acres			
		Third Five-Year Plan		Fourth Five-Year Plan	
		Total cultivated area	Area which should be under irrigation	Total cultivated area	Area which should be under irrigation
1	Rice	..	..	16	4
2	Wheat	..	..	16	7
3	Jowar	..	..	33	2 (part)
4	Bajri	..	..	38	2
5	Pulses	..	..	14	..
6	Other food crops	..	..	11	3
7	Cotton	..	..	40	2
8	Tobacco	..	..	2.25	0.75 (part) 0.30 (full)
9	Groundnut	..	..	35	0.30
10	Sugarcane	..	..	1	1
11	Miscellaneous crops	..	..	34	1.75
		Total ..	240.25	24.10	240.25
					33.60

The requirements of nitrogenous fertilisers based on the cropping pattern suggested above are given below. While working out these figures, there are deviations from the dozes for different crops, given by Government of India in 'Approach to Agricultural Development in the Third Five Year Plan' particularly in the case of irrigated rice, wheat, tobacco and sugarcane. Our experience in paddy pilot scheme in Gujarat has proved that 40 lbs. of Nitrogen per acre is necessary as against 20 lbs. Nitrogen suggested by Government of India. Same applies to wheat. Regarding tobacco, the Government of India recommends the doze of 40 lbs. but as most of the area under tobacco in Gujarat State is under 'Bidi type' of tobacco, the work at Agricultural Institute, Anand has definitely shown that 100 to 120 lbs. of Nitrogen is necessary to get the maximum returns from an acre of tobacco. So, the doze of 60 lbs. of Nitrogen per acre of tobacco in Gujarat is considered reasonable. The doze taken for calculating the requirements of Nitrogen for sugarcane by Government of India is 80 lbs. The experience of canal area of Maharashtra shows that a doze of 300 lbs. of Nitrogen per acre gives high yields. A figure of 200 lbs. per acre is, therefore, adopted.

In view of the above mentioned consideration, the requirement of nitrogenous fertilisers will be as under :—

TABLE VII

No.	Crops	Doze of Nitrogen in lbs. per acre	Area at the end of TFYP in lakh acres	Nitrogen required in lbs. (lakhs)	Area at the end of FFYP in lakh acres	Nitrogen required in lbs. (lakhs)
1	2	3	4	5	6	7
1	Rice (Irri.)	.. 40	4.00	160.00	6.00	240.00
2	Rice (Rainfed)	.. 20	12.00	240.00	12.00	240.00
3	Wheat (Irri.)	.. 40	7.00	280.00	9.00	360.00
4	Wheat (dry)	.. 10	3.00	30.00	5.00	50.00
5	Jowar (Irri.)	.. 20	2.00	40.00	43.00	60.00
6	Jowar (dry)	.. 10	2.00	20.00	4.00	40.00
7	Bajri (Irri.)	.. 20	2.00	40.00	3.00	60.00
8	Bajri (dry)	.. 10	2.00	20.00	4.00	40.00
9	Other food crops (Irri.)	.. 25	3.00	75.00	3.50	87.50
10	Do. (dry)	.. 10	1.00	10.00	1.50	15.00
11	Cotton (Irri.)	.. 40	2.00	80.00	3.00	120.00
12	Cotton (dry)	.. 10	4.00	40.00	4.00	40.00
13	Tobacco	.. 60	2.25	135.00	2.25	135.00
14	Groundnut	.. ..	..	..	..	..
15	Sugarcane	.. 200	1.00	200.00	2.00	400.00
16	Miscellaneous crops	.. 20	1.75	35.00	2.10	42.00
Total ..				1,405.00 lbs. = 62,723 tons.		1,929.50 lbs. = 86,135 tons.
Additional requirements for land under assured Rainfall.		30	19.00	28,500 tons.	9.94	13,000 tons.
Grand total ..				91,223 tons.		99,135 tons.

It is understood that an area of 1,95,000 acres of Khar lands of Broach and Surat districts will be reclaimed during the period 1961 to 1971 and at least 50 per cent. of this land will be under paddy cultivation, as such it will require additional 2,000 tons of 'Nitrogen'.

2.7. Requirement of nitrogen for different crops as per work done at the Agricultural Institute, Anand.— Extensive work has been done on this problem at the Institute of Agriculture, Anand. By about 1965 the total gross cropped area in Gujarat State would be as follows :—

	Total Gross Cropped Area	Acres
(A) Gujarat .. .. ..	.. 1,41,26,300	
(B) Saurashtra .. .. ..	.. 82,38,000	
(C) Kutch .. .. ..	.. 11,15,000	
	<hr/>	<hr/>
Total Gross cropped area ..	.. 2,34,79,300	<hr/>
	<hr/>	<hr/>

The total cropped area is sub-divided as follows :—

	Acres
(a) Cash crop area .. .. ..	.. 64,90,000
(b) Cereal crop area .. .. ..	.. 1,69,89,300
	<hr/>
Total ..	2,34,79,300
	<hr/>

The cash crops such as sugarcane, ground-nut, tobacco and cotton at 80 lbs./acre would need 2,32,000 tons nitrogen per year, while the acreage under cereal crops at maximum permissible and possible irrigation of 50 per cent. would amount to 84,94,650 acres. This acreage receiving on an average 30 lbs. nitrogen per year would need 1,13,800 tons of nitrogen per year.

Note.—The assumption of 50 per cent. area of cereal crops under irrigation is based upon the availability of ideal conditions, after Fifth Five Year Plan when our economy, agricultural as well as industrial, would have taken off. In fact, this area is well within the practical possibilities of benefitting from the irrigation projects in the envisaged period of the Fifth Five Year Plan.

Thus, total requirement of Nitrogen :—	Tons.
For cash crop area .. .. ..	.. 2,32,000
For other crop area .. .. ..	.. 1,13,800
	<hr/>
Total ..	3,45,800 per year.
	<hr/>

2.8. Necessity for nitrogenous fertiliser production plants.—When the situation regarding the production of nitrogenous fertilisers is viewed against the background of the target requirements of nitrogenous fertilisers in the country, the programme under implementation appears to be quite inadequate. It is, therefore, necessary to remember future requirements of nitrogenous fertilisers in the country as a whole and in Gujarat area in particular. Regarding the number of units of the fertiliser plant, it should be suggested that taking into account the ultimate requirements of about 3,50,000 tons of nitrogen per year for Gujarat Area, there could be at least two fair sized fertiliser plants in Gujarat State, one for immediate implementation of the capacity of 96,000 tons Nitrogen per year and the other similar one at a later date.

As far as Gujarat is concerned, consensus of opinion is that in this area the requirements of the types of nitrogenous fertilisers should be as follows :—

- (1) Urea,
- (2) Ammonium Phosphate,
- (3) Ammonium Sulphate.

Details of this pattern of production are discussed in the next chapter.

CHAPTER III

TYPES OF NITROGENOUS FERTILISERS CONTEMPLATED TO BE PRODUCED AND QUANTITIES THEREOF

3.1. Before attempting to evolve a pattern of fertiliser production in Gujarat, it would be appropriate to study briefly the world pattern and progress in this field.

The estimated world production of nitrogen, phosphoric acid (P_2O_5), and potash (K_2O) in 1958-59 was nearly eight per cent. greater than the figure for 1957-58 and more than 13 per cent. higher than 1956-57. This favourable development shows that nitrogen, phosphoric acid and potash are applied to an ever rising extent to increase the agricultural productivity throughout the world.

				1956-57 figures in tons per year	1958-59 figures in tons per year
Nitrogen	..	..	..	73,00,000	88,00,000
Phosphoric acid	..	..	..	75,00,000	83,00,000
Potash	..	..	..	67,00,000	73,00,000

The population of the world increases by 1,00,000 people daily. They must be all adequately fed. Besides, we are aiming at a rise of living standards in all countries. Thus the need for foodstuffs is increasing even more rapidly than the population. This applies particularly to India. India has approximately 15 per cent. of the total world population. Taking the world figures of fertiliser production population-wise, we arrive at the Indian requirements (annual tonnage) of fertilisers as follows :—

			World figures 1958-59	15 per cent. of the world figures	Indian target for T. F. Y. P.
Nitrogen	..	..	88,00,000	13,20,000	10,00,000
Phosphoric acid	..	..	83,00,000	12,45,000	5,00,000
Potash	..	..	73,00,000	10,95,000	1,00,000

This comparison suffers from the fact that Indian contribution in the world figures of production, population-wise has been insignificant so far. World figures of production at the present rate of growth in production will be 33 per cent. more in 1965 when Indian targets are expected to materialise. It also reveals a lacuna in our programme, of insufficient attention being paid to phosphatic and potasic fertilisers.

It is recognised that the task of raising agricultural productions in India is not possible by enlarging the area under cultivation ; the aim has, therefore, to be directed towards increasing the yield per unit area, *i. e.* by intensive cultivation methods. In addition to improvement in cropping and cultivation methods (*i. e.* soil and water conservation, modern soil treatment, improved seed stocks, modern machines, plant protection

measures, etc.) the introduction of mineral fertilisers and organic manures is one of most effective means for increasing agricultural output and hence the most powerful weapon in the fight against hunger and malnutrition.

The world consumption of fertilisers as indicated earlier has reached about 23 million tons of plant nutrients. This consumption, however, is concentrated in the more highly developed countries with already a fairly intensive agriculture; great efforts, therefore, must be made to raise production and the use of fertilisers especially in the little developed agricultural lands of India.

3.2. But in practical agriculture, one must realise that a permanent increase in the soil productivity resulting from mineral fertilisers can only be expected if fertilisers with a balanced proportion of nitrogen, phosphoric acid and potash are used, which means in a ratio that confirms to the needs of the plant. Very often, at the beginning of fertiliser treatment, particularly on virgin soils, crop yields may be increased by the application of only one of the nutrients mentioned; but such yield increases will always have a temporary limited effect and soon leads to the exhaustion of the soil store of other nutrients. This results into declining yields.

Long term experiments have proved that plants take up the nutrients-nitrogen, phosphoric acid and potash—generally in a ratio of 1 : 0.5 : 1.5 especially if the soil has been cropped for a long time. Therefore, if for example, plant growth is increased by the application of nitrogen, the plants necessarily also require larger amounts of phosphoric acid and potash, because the equilibrium of these three nutrients may not be disturbed for a normal growth of the plant.

Every one-sided fertiliser treatment, therefore, in the long run, is an exhaustion of the soil capital and not economical, whilst fertiliser treatment with nitrogen, phosphoric acid and potash in the correct ratio is the most effective and profitable means of increasing permanently the productivity of the soil.

Fundamental law of the harmonious fertiliser treatment, suited to the needs of the plant is, therefore, an absolute necessity; with this background in view, planning of production of all the three major soils nutrients becomes obvious. So far as Gujarat is concerned local production of potash is a practical possibility. Bitterns from the inland and marine salt works could be exploited for this purpose. Bitterns, the mother liquor remaining in the pans from which common salt crystals have been collected, contain appreciable quantities of salt, magnesium chloride and small quantities of potassium chloride. Efforts are afoot to evolve a process suitable to recover potash chloride from this source. As 2/3rd of the total salt production of India is confined to the coasts of Saurashtra and Kutch, the State of Gujarat stands to profit by concentrated efforts in this direction.

As for nitrogen part, ammonium sulphate has been popular in India and in Gujarat because it has been used since last fifty years. Besides imports, it has been produced first as a bye-product from the coking plants in India and later from a small unit established at Belagula, Mysore. As a result, the larger units at Sindri and Alwayee were also planned to produce ammonium sulphate. At Sindri, the sulphate part is generated from gypsum (calcium sulphate) and at Alwayee from sulphuric acid made from imported sulphur.

The source of gypsum originally was Khewra in Punjab but with the creation of Pakistan, India lost this source and had to rely on Bikaner gypsum, involving a long lead and transhipments from meter to broad gauge which adds to the gypsum cost. The cost becomes so great and transport so difficult that sometimes Bikaner gypsum had to be supplemented by imported cyprus gypsum. As this is the only known source of good grade gypsum in India, it was later realised that future productions of nitrogenous fertilisers should be in forms other than ammonium sulphate. As a result, Nangal Fertilisers planned to produce nitro chalk (mixture of ammonium nitrate and limestone) and urea was considered as nitrogenous fertiliser at Neyveli and for further expansion of Sindri. Rourkela was planned to produce urea and double salt of ammonium nitrate sulphate. Excepting Rajasthan plant which will have a ready source of gypsum available at their door, plants producing only ammonium sulphate will have to be avoided.

From the angle of saving transport costs of bulky finished product in order of nitrogen content, urea gets the first preference as it contains 46 per cent. nitrogen available as plant food. Ammonium chloride would come second best containing 26 per cent. of nitrogen. Its suitability for all types of soils and crops, however, is not as good as other nitrogenous fertilisers while ammonium sulphate-nitrate mixtures are preferred because of their higher nitrogen content, pound for pound as compared to either ammonium sulphate or nitro-chalk both of which contain 20/21 per cent. available nitrogen. Viewed from this angle, urea selects itself.

3.3. Along with nitrogen, Gujarat has, as indicated earlier in this chapter, to plan *paripassu* production of phosphates with available P_2O_5 to supply balanced nutrients to the soil. Gujarat soils are comparatively poor in nitrogen and phosphoric acid and as such together with a production of 96,000 tons nitrogen annually a production of phosphates containing 96,000 tons P_2O_5 (equal to 5,70,000 tons single super phosphate) would be called for. All India planning of phosphates, however, is reduced to a possibly attainable target of 0.5 million tons P_2O_5 in the Third Five-Year Plan, as against one million tons of nitrogen. Gujarat should aim at manufacturing between 50,000 to 100,000 tons P_2O_5 annually. Present installed capacity in Gujarat area is 32,000 tons single super phosphate (5,333 tons P_2O_5) annually. A further capacity for 66,000 tons single super at Surat and Verawal is licensed. Total availability of P_2O_5 in production and planned will thus amount to 15/16,000 tons annually. This leaves a gap of minimum 35,000 but 85,000 tons optimum need of P_2O_5 , thus maintaining and if possible excelling the proportion of P_2O_5 in the mixed fertilisers.

Certain crops such as groundnut and tobacco are known to react favourably to the phosphoric acid constituent of the fertiliser mixture; for these crops ammonium phosphate has proved a very good fertiliser. Ammonium phosphate (11 : 48 mixture) production is now standardised and the manufacturing methods established. Production of ammonium phosphate at any place in Gujarat would necessitate import of rock phosphate and sulphur. These two raw materials are being imported and will continue to be imported for the production of single superphosphate containing 16 to 18 per cent. P_2O_5 (the rest merely supplying inert material to the soil). Instead of making superphosphate and mixing it with nitrogenous fertilisers before application to the soil, it would be any day a better proposition to utilise the same raw materials for the production of complete fertilisers, like ammonium phosphate, containing 11 per cent. available nitrogen and 48 per cent. available P_2O_5 . If need be the proportion of nitrogen to P_2O_5 could be varied over a wide range to suit individual crops and soils. It is no mean advantage in that such concentrated fertilisers reduce the costs due to labour, packaging and transports. An additional advantage in adopting production of ammonium phosphate is that by-product calcium sulphate slurry (gypsum) provides the necessary vehicle to fix ammonia as ammonium sulphate — the popular fertiliser.

3.4. It is realised that import of sulphur involves foreign exchange considerations and this cannot be lightly brushed aside. Though the importance of phosphatic fertilisers has been realised, its production targets have been kept low as foreign exchange involved in importing sulphur has been a serious consideration. World prices of sulphur has been falling however steeply since last one year. Present C. I. F. cost is almost half that ruling in 1952-53 (Korean crisis). This is due to over-production of sulphur all over the world. Again indigenous production of sulphur from available Amjor Pyrites deposits will be realised early in the Third Five Year Plan. Thus the foreign exchange problem for sulphur will be greatly eased. In addition, sulphur used in making ammonium phosphate becomes available as calcium sulphate in the productions of ammonium sulphate; it is, therefore, doing twice the service it renders in the production of single superphosphate. These considerations are very cogent in deciding in favour of ammonium phosphate.

To get a balanced production after considering all the advantages indicated above and to avoid unnecessary increased capital costs due to such diversified productions,

a balance has been struck to produce annually 96,000 tons of nitrogen in the following types of nitrogenous and phosphatic fertilisers :—

Annual nitrogen tonnage	As	Annual product tonnage
40,000	Urea	90,000
14,000	Ammonium Phosphate	1,25,000
42,000	Ammonium Sulphate	2,00,000
<hr/> 96,000		<hr/> 4,15,000

Note.— To manufacture 1,25,000 tons of ammonium phosphate, an import of 2,22,000 tons rock phosphate 64/65 BPL and 57,000 tons of sulphur per year will be involved.

It will be evident that production of ammonia gas is common to all the three products. For a plant of the above capacity, the major item of cost will be that due to ammonia and this will be distributed to all the three end products.

Cost of ammonium sulphate is also reasonably low in view of the fact that there is no cost contribution due to the sulphate part requiring sulphuric acid or gypsum and carbon-dioxide gas also available as by-product of synthesis gas products

Similarly the carbon-dioxide gas needed in the urea production (ammonia and carbon-dioxide under pressure at elevated temperatures yields urea) also does not bear any cost in as much as it is the by-product of the synthesis gas manufacture. In fact, carbon-dioxide needed for urea and that required for conversion of ammonia into ammonium sulphate will all be available as by-product of the production of synthesis gas. All these considerations justify the proportions of the three end products taken for producing 96,000 tons nitrogen needed.

A reference to the costings of the products attempted in the subsequent chapter will bear out the above contention. The nitrogen-hydrogen mixture in the ratio of 1 to 3 react catalytically at high temperature and pressure to produce ammonia. The nitrogen is derived from the air by means of liquefaction, the producer gas reaction or selective burning out the oxygen in the air with either hydrogen or carbon part of the hydro-carbons.

3.5. Hydrogen sources are water gas, coke-oven gas, natural gas, fuel or crude oil, catalytic reformer gases and electrolysis of water or brine. Since World War II, natural gas as such or reformed has become the most important source, so much so that in the great expansion after the war, ammonia has become known as a petrochemical (*i. e.* a chemical derivative of petroleum). To-day petroleum or natural gas-derived ammonia represents more than 90 per cent. of production and ammonia is number one petrochemical in terms of volume of production. The particular process chosen for a given plant depends upon many factors but the main differences are sources of raw materials and method of preparing synthesis gas. Improvements in the methods of tonnage oxygen (95 per cent. purity) has resulted in wide acceptance of the hydrocarbon partial oxidation process. This process is particularly attractive since co-product nitrogen is one of the required raw materials for ammonia synthesis. The partial oxidation process is applicable to fuel oil and coal as well as natural gas and other light hydro-carbons (solvent naphtha).

The general increase in catalytic reforming of petroleum stocks has also led to large supplies of hydrogen (upto 93 per cent. purity) at refinery sites. In some cases this has become the raw material for ammonia synthesis. Such plants have probably the lowest investment cost of any synthesis gas facility. Obviously, however, there are some ammonia plant locations where refinery streams are not available. At such locations, imported solvent naphtha, fuel or furnace oil, bunker 'C' oil or even crude oil could be adapted to achieve the nitrogen-hydrogen synthesis mixture and carbon-dioxide, a by-product which would come useful in the subsequent conversions to urea and ammonium sulphate.

Gujarat, has, therefore any of the above raw materials to select from. Refinery streams would of course be a welcome source of synthesis gas for ammonia but even if this were not available, the choice could be made from imported solvent naphtha, bunker or furnace oil or crude oil.

It seems the two Bombay refineries will have surplus solvent naphtha even after providing for the Trombay fertiliser unit. Instead of exporting this surplus out of India, it could profitably be brought to the Gujarat fertiliser unit by rail or sea according to location.

Imbalance in the output of refinery products and consumption trends normally should provide hydro-carbon stream needed for synthesis gas. As such, use of solvent naphtha surplus from TROMBAY suggests itself.

The targets of requirements of oil products in the Third Five-Year Plan and possibility of utilising the indigenously available crude oil stocks, leave a gap which must be met by imports. In view of this fact, the question of utilising locally available crude oil in Gujarat or the refinery gases assume secondary importance *viz-a-viz* the use of imported crude oil or its economically available products.

For the proposed nitrogenous fertiliser plant in Gujarat, light naphtha from the Bombay refineries is available and can be used. If need be and subject to the rates being economic, either Bunker 'C' oil or even Crude oil can be imported and used as raw material. At a future date, either gas stream or liquid stream or both, as and when available from refineries located in Gujarat, can be used. Based upon this conclusion, the facilities needed to establish productions indicated earlier in quantities mentioned against each and production costs are discussed in subsequent chapter.

3.6. (a) Phosphate Rock.—In addition to the hydro-carbons discussed above, production of ammonium phosphate will need the use of imported rock phosphate to the extent of 2,22,000 tons per annum. For the plan of supply of fertilisers, this much utilisation of rock phosphate would be necessary to produce either single super-phosphate, double super-phosphate or triple super-phosphate. Single super-phosphate has the disadvantage of containing only 16/18 per cent. available and essential P_2O_5 , the rest being inert material. This involves handling of greater bulk per unit of P_2O_5 as also more packing material and heavier transport charges incidental to such bulk. Double and triple super-phosphate containing 35 and 45 per cent. P_2O_5 respectively have the disadvantage of higher manufacturing cost with no proportional advantages enjoyed by ammonium phosphate *viz.* the additional nitrogen content. Again this single, double and triple supers are acidic in character and damage the jute bags in which they are packed.

The phosphate content of ammonium phosphate on the other hand could be varied within wide range without changing the pattern of the plant. All these have been mentioned to stress and point out that foreign exchange will necessarily be involved in importing rock phosphate for the phosphoric acid part of the balanced and harmonious mixed fertiliser.

(b) Sulphur.—Few years ago, it was extremely difficult to get imported sulphur with the result that at that time the general thinking in the country was that at any cost India should develop its own sources of sulphur. At the same time, it was seriously considered, even though it might be considerably more expensive, to recover sulphur from gypsum to reduce our dependence on sulphur from foreign countries. Since then, things have changed, all over the world, considerably. New sources of sulphur have been discovered in Mexico and U. S. A. Large quantities of natural gas containing a very high percentage of hydrogen sulphide have been discovered in France and in Canada. Both these countries are using these natural gases for thermal and petro-chemicals use. However, before such sour gas can be used, it is absolutely essential that H_2S in the gas should be removed. A large quantity of sulphur is being recovered now in France and increasing quantities will be recovered in future and even larger quantities of sulphur from natural gases in Canada. It is expected that Canadian sulphur might begin to come in the market towards the end

of this year. As a result, the price of sulphur is going down continuously with the result that the present day price is only Rs. 140 per ton. Again, large deposits of pyrites have been discovered in India. The proven deposits of pyrites in Amjor area alone are about 80 million tons. Steps are being taken to manufacture elemental sulphur from these pyrites, and a Company has been formed by N. R. D. C. known as Pyrites and Chemicals Development Corporation Ltd. and it is very likely that some elemental sulphur or sulphur bearing materials will be available indigenously. Because of these changed conditions about the availability of sulphur, there should be no hesitation in formulating any scheme which is basic and desirable to have, based on imported sulphur.

The Committee considered all these points carefully and came to the conclusion that the pattern of production of fertilisers in Gujarat should be :—

- (a) To manufacture granulated ammonium phosphate (11 : 48) and,
- (b) Calcium sulphate which is a bye-product from the ammonium phosphate plant should be utilised for the manufacture of ammonium sulphate.

Because gypsum is available at no cost in this pattern of production, the production of ammonium sulphate this way becomes cheap and the cost of production of ammonium sulphate becomes comparable with other nitrogenous fertilisers.



CHAPTER IV

CONSIDERATION OF FACILITIES REQUIRED

4.1. Site.— Site admeasuring 1,000 acres would be considered ideal for locating such a unit of making 1,00,000 tons nitrogen and 60,000 tons phosphoric acid. Out of these 1,000 acres, 400 acres will be earmarked for factory site and 600 acres for township. The site should have liberal area for plants such as :—

1. Sythesis gas making unit.
2. Gas compressor House.
3. Synthetic Ammonia House.
4. Urea Plant.
5. Sulphuric Acid Plant.
6. Phosphoric acid unit.
7. Ammonium Phosphate unit.
8. Ammonium Sulphate unit.
9. Power House—Thermal.
10. Three storage houses.
11. Maintenance workshop.
12. Tank farm for storage of Hydrocarbons.
13. Water reservoir and pump house.
14. Main office building.
15. Laboratories for control and quality checks for raw materials, and finished products.
16. Staff quarters.
17. Labour quarters and township facilities.
18. Hospital and school.
19. Guest House.

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The buildings should be planned fairly spaciously to provide for railway sidings, to bring the raw materials and take away the finished products.

The sites should be within reasonable vicinity of the source of water supply and existing township from which trained labour and technical staff could be drawn.

Water.— Water works capable of handling eight million gallons per day would be called for. Cooling water supply of fresh water would be preferred. Sea water could be used for the purpose, but it would involve a higher capital outlay than estimated in these costs. In ultimate production cost, however, reflection of such cost would be counter balanced by cheaper day to day costs of sea water.

Process water and water used in the boilers must be free from temporary and permanent hardness as far as possible.

The cost of raw water and its treatment will depend on the location of the fertiliser plant as well as the analysis of raw water, and therefore, no attempt has been made to work out the detailed costing for the different types of water. Only the estimated costs of different types of water have been assumed for evaluating the cost of production of various products. It will, however, be noticed that the cost of water forms a very small percentage in the total cost of production, and, therefore, the variation in the actual cost of water will not materially affect the ultimate cost of production of any fertiliser.

Power.—Because high pressure by-product steam will be available from other processes for use in the power house, and because of requirement of low pressure steam for processing purposes from the power house, it will be profitable to have an independent power plant as part of the fertiliser production unit.

A capacity of 26,000 KW continuous supply and 50 per cent. of standby capacity needs to be provided.

Power cost as computed will be 8 nP. per KWH inclusive of duty and 12 per cent. return on block capital.

4.2. Effluent Disposals.—In the manufacture of Nitrogen, Hydrogen and Carbon-dioxide from the mineral oil products, in the refining of these gases to free them from objectionable impurities such as oxygen, carbon-monoxide, moisture etc. and in the production of Phosphoric acid and urea process-effluents of acidic and alkaline characters injurious to public health will be produced and their disposal will have to be considered.

The cheapest method of disposal of the effluents will be to discharge them without any treatment into a nearby creek. All the locations examined in this report are on the sea-coast or gulf coast, and as such with necessary precautions, any pollution or contamination could easily be avoided. While discharging the effluents care could be taken to safeguard any shallow or deep sea fishing practices adopted at present or likely to be adopted in future.

4.3. Labour and Overheads.—In a chemical factory of this nature, cost due to labour in the ultimate product costs is insignificant but provision has to be made to train the labour for skilled process operations.

Technically qualified labour and supervisory staff becomes an important issue and regular supply of such personnel becomes an important consideration. All the suggested locations are near Universities which train a fairly large number of technical personnel.

Personnel

		Managerial	Supervisory	Skilled	Un-skilled	Others
1	Production, Laboratory, research and development.	20	100	500	278	..
2	Maintenance including storage	..	26	120	400	220
3	Services	..	..	70	100	88
4	Office	..	..	12	24	200
	Total	..	66	314	1,200	586
						200
						Grand Total .. 2,366

Superior Management —

Governing Director	..	..	..	..	1
General Manager	..	..	..	..	1
Chief Engineer	..	..	..	..	1
Chief Chemist	..	..	..	..	1
Purchase Officer	..	..	..	..	1
Sales Manager	..	..	..	..	1
Projects Officer	..	..	..	..	1
Public relation	..	..	..	..	1
Stores Suptd.	..	..	..	..	1
Transport Officer	..	..	..	..	1
					<hr/>
					10
					<hr/>
Office staff	..	..	..	..	60

Power House—

Plant Superintendent	..	..	..	..	1
Electrical Engineer	..	..	..	..	1
Mechanical Engineer	..	..	..	..	1
Maintenance Chief	..	..	..	..	1
Skilled staff	..	..	..	..	60

The above picture applies to the battery limit of 5 units viz. power plant, Ammonia plant, Urea plant, Ammonium Phosphate plant and Ammonium Sulphate plant.

Adding further 500 persons as packing labour the total amounts to 3,000 persons. In addition to labour and supervision will be necessary for the following :—

1. Land maintenance.
2. Railway siding.
3. Materials handling.
4. Maintenance Workshop.
5. Fire Protection.
6. General Laboratory.
7. Administration.
8. Watch and Ward.
9. Hospital, Schools etc.
10. Township.
11. Water works.

4.4. Transport.—Wagon movements for the raw materials and finished products at full production capacity would be as under :—

Raw Material etc.—

				Tons / Year
1. Coal for power house	..	..	..	92,000
2. Light Naphtha	..	..	..	113,500
3. Phosphate rock	..	..	..	222,000
4. Sulphur	..	..	..	57,000
5. Packing materials @ 15 jute bags / ton.			..	6,000
6. Stores (lubricants, Paints refractories, spares, alkali acids, cotton-waste, twine, etc).			..	12,000
7. Township stores	..	..	..	12,000
				<hr/>
				514,500
				<hr/>

daily 1,470 tons involving 75 B. G. wagons.

150 M. G. wagons.

In case of a port with steamer unloading facilities, only part of this load would be required to be moved by rail and the needs would then be;

daily 330 tons or 17 B. G. wagons.
35 M. G. wagons.

Proximity to sea port will thus reduce the load on rail transport.

Finished Products

				Tons / Year
1. Urea	..	..	..	.. 90,000
2. Ammonium phosphate	..	..	..	.. 125,000
3. Ammonium sulphate	..	..	..	.. 200,000
				<hr/> <hr/>
				415,000
				<hr/> <hr/>

Taking 350 days working,

daily Load would be	1,186 tons.
Involving broad-gauge wagons	60 daily.
Meter-gauge wagons	120 daily.

Communications (Post and Telegram and Telephone) and easily available approach-roads for transport would also add to the importance of the site selected.



CHAPTER V

CAPITAL COST AND UNIT COST OF EACH TYPE OF NITROGENOUS FERTILIZERS

I. Total Investment.— The total capital investment required for all plants such as Ammonia, Urea, Ammonium Phosphate, Ammonium Sulphate and Power Plant, has been estimated on information obtained from the machinery suppliers and technical groups working in industry and in fertiliser plants.

The summary of investment is given below :—

Plants	Capacity	Plant and machinery as erected and ready for regular operation	Building and all other C. E. works	Working Capital
		(Rs. × 1000).		Rs.
1. Ammonia Plant ..	.. 128,000 T/Year	87,000	10,000	5,000
2. Urea Plant ..	.. 90,000 ,,	33,000	4,000	2,000
3. Amm. Phosphate ..	.. 125,000 ,,	26,000	3,000	10,000
4. Amm. Sulphate ..	.. 200,000 ,,	43,000	6,000	5,000
5. Power Plant ..	.. 2,600 KW	36,000	4,000	3,000
6. Water Works ..	.. 8 M. Gal/day	2,000	1,000	
7. All Miscellaneous items ..	..	8,000	9,000	
8. Township ..	..		10,000	
Total	..	235,000	47,000	25,000
GRAND TOTAL	..	307,000		

Of the total investment, it is estimated that about Rs. 14 crores will be foreign exchange content, while rest will be Rupee expenditure. It is likely that the estimated investment on any single item might vary somewhat. However, the total investment on the whole project as indicated in the report will be fairly accurate. Incidentally, it may be pointed out that several engineering firms are now manufacturing more and more chemical plants and equipment in the country and it is likely that by the time this project goes into operation, several more machines and equipment will be available indigenously, with the result that the actual requirement of foreign exchange might work out considerably less than what is estimated in the report. Perhaps this figure can come down as low as Rs. 11 crores.

II. Details of Miscellaneous Investment

				Rs.
A.	Preliminary Expenses	..	..	5,00,000
B.	Land and preparation of land	..	..	15,00,000
C.	Railway siding and material handling equipment	..	..	40,00,000
D.	Maintenance Workshop	..	..	20,00,000
E.	Fire Protection	..	..	5,00,000
F.	General Laboratory	..	..	10,00,000
G.	Furniture, etc.	..	..	5,00,000
H.	Administration and other Misc. C. E. Works	..	..	20,00,000
I.	Contingencies	..	..	50,00,000
				<hr/>
			Total	1,70,00,000
				<hr/>

This may be divided as :—

				Rs.
Investment similar to plant, etc.	..	..	..	70,00,000
Investment on building, etc.	..	..	..	1,00,00,000

III. Expenses on Miscellaneous items

				Rs.
Total investment on miscellaneous items ..				.. 1,70,00,000
This may be divided into two parts :—				
Similar to plant and machinery 70,00,000

Similar to Building, C. E. Works 1,00,00,000
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				Rs.
Depreciation @ 10 per cent. on Rs. 70,00,000 7,00,000
Depreciation @ 5 per cent. on Rs. 1,00,00,000 5,00,000
Insurance @ $\frac{1}{2}$ per cent. on Rs. 1,70,00,000 ..				.. 42,500
Power + light + miscellaneous expenses ..				.. 60,000
				<hr/>

Total ..				13,02,500
Say ..				13,00,000

Add : 12 per cent. return on capital of Rs. 1,70,00,000 ..				.. 20,40,000
			Total ..	33,40,000

These charges may be distributed as follows :—

					Rs.
Ammonia Plant ..	..	..	..	..	12,70,000
Urea Plant ..	..	..	..	..	4,84,000
Ammonium Phosphate ..	..	..	..	..	3,80,000
Ammonium Sulphate ..	..	..	..	..	6,42,000
Power Plant ..	..	..	..	..	5,24,000
Water Works ..	..	..	..	..	40,000
				Total ..	33,40,000

IV. Water Works.— The cost of raw water and its treatment will depend on the location of the fertiliser plant as well as the analysis of raw water, and therefore, no attempt has been made to work out the detailed costing for the different types of water. Only the estimated costs of different types of waters have been assumed for evaluating the cost of production of various products. It will, however, be noticed that the cost of water forms a very small percentage in the total cost of production, and therefore, the variation in the actual cost of water will not materially affect the ultimate cost of production of any fertiliser.

V. Notes on township facilities.— Expenses on township facilities have been taken as Rs. 1,00,00,000.

Expenses for township :—

	Rs.
1. Interest @ 6 per cent. on Rs. 1,00,00,000	.. .. 6,00,000
2. Maintenance of Township @ 1 per cent.	.. .. 1,00,000
3. Expenses for Hospital, School, etc. ..	.. .. 1,00,000
	<hr/>
	Total .. 8,00,000
	<hr/>
4. Less : Recovery by way of rent, power and water	.. 2,00,000
	<hr/>
	Net .. 6,00,000
	<hr/>

These charges may be distributed as follows :

	Rs.
(a) Ammonia Plant 2,60,000	
(b) Urea Plant 1,00,000	
(c) Ammonium Phosphate 1,00,000	
(d) Ammonium Sulphate 1,00,000	
(e) Power Plant 30,000	
(f) Water Works 10,000	
	<hr/>
	Total .. 6,00,000
	<hr/>



VI. Yearly cost of operating the Power Plant

Assumptions :

- (i) Credit has been given for surplus steam generated in waste heat boilers in other departments at the rate of Rs. 3 per 1,000 lbs.
- (ii) Low pressure steam is charged at the rate of Rs. 3 per 1,000 lbs.
- (iii) It is assumed that about 2,000 KW of power will be utilised in the Power House itself for such purpose as circulating water pumps, induced and draught fans, feed water pumps, lighting, conveying, etc.
- (iv) Return on block investment has been taken as 12 per cent.
- (v) Price of coal has been taken upto factory site. It also includes probable transit losses.
- (vi) Capacity : 26,000 KW continuous supply and 50 per cent. of standby capacity.

Investment :

			Rs.
Plant	..	..	3,60,00,000
Building	..	..	40,00,000
Working Capital	..	..	30,00,000
			<hr/> <hr/> 4,30,00,000

Yearly cost :

			Rs.
1. * (a) Coal 92,000 tons @ Rs. 54 ton	..	..	49,68,000
(b) Credit to be given for steam	..	..	20,00,000
2. Maintenance and supplies 2 per cent. on Rs. 4,00,00,000 and all miscellaneous expenses.			8,00,000
3. Water both cooling and demineralizing	..	..	6,00,000
4. Labour and overheads	..	..	2,00,000
5. Depreciation on machinery @ 10 per cent. on Rs. 3,60,00,000	..	..	36,00,000
6. Depreciation on building @ 5 per cent. on Rs. 40,00,000	..	..	2,00,000
7. Insurance @ $\frac{1}{4}$ per cent. on Rs. 4,00,00,000	..	..	1,00,000
8. Interest on Working Capital @ 6 per cent. on Rs. 30,00,000	..	..	1,80,000
9. All other miscellaneous expenses	..	..	2,20,000
10. Expenses on miscellaneous items, allocation	..	..	2,00,000
11. Expenses on Township, allocation	..	..	30,000
			<hr/> 1,30,98,000
<i>Less:</i> —Low pressure steam supplied to other plants @ Rs. 3/1,000 lbs.	..	..	21,40,000
			<hr/> 1,09,58,000
		Say	1,09,50,000

$$\text{Cost of Power per Kwh in nP.} = \frac{1,09,50,000 \times 100}{(26,000)(24)(350)}$$

$$= 5.0 \text{ nP.}$$

$$\text{Electricity duty} = 0.8 \text{ nP. per KWH.}$$

$$\underline{5.8 \text{ nP. per KWH.}}$$

$$12 \text{ per cent. return on block of Rs. } 4,00,00,000 = 48,00,000$$

$$(48,00,000)(100)$$

$$\text{Therefore Cost/Kwh} = \frac{(48,00,000)(100)}{(26,000)(24)(350)} = 2.2 \text{ nP.}$$

$$\text{Therefore Total cost per Kwh} = 5.8 + 2.2 = 8.0 \text{ nP.}$$

*(If naphtha is available at Rs. 108/ton, it can be used instead of coal as fuel in power plant).

VII. Cost of Production of Ammonia

96,000 Tons Nitrogen = 1,17,000 Tons of Ammonia per year of 350 days.
 = 335 Tons / day.
 = 14 Tons / hour.

Note. — The most important raw material for the manufacture of ammonia is the feed-stock, namely Light Naphtha. In this particular case, it is assumed that the price of Light Naphtha would be Rs. 115 per ton upto the plant site. Taking that for this particular case, it is possible to use other petroleum stream such as furnace oil, fuel oil or even crude oil as raw material ; the price of Light Naphtha should therefore, be not more than the equivalent price for such petroleum stream available such as furnace oil, crude oil, etc. either imported or indigenous.

Investment :

	Rs.
Plant .. ..	.. 8,70,00,000
Building .. ..	.. 1,00,00,000
Working Capital and spares	50,00,000
	<hr/> <hr/> 10,20,00,000

Yearly Cost :

	Rs.	Say Rs.	Per ton
1. Light Naphtha 1,05,000 tons @ Rs. 115 ton.	12,125,000		
Light Naphtha for heating purposes 8,500 tons.	977,000	13,060,000	102.00
2. Power, 1110 Kwh/Ton NH ₃ @ 8 nP. per Kwh.		11,400,000	89.20
3. (a) Water, cooling, 5,000 gallons/Ton NH ₃ @ 50 nP. / 1,000 Gal. (b) Other water	320,000 30,000	350,000	2.74
4. Labour, supervision and overheads .. ..	.. ..	2,000,000	15.60
5. Maintenance, supplies and all other miscellaneous expenses and services @ 4 per cent. on Rs. 97,000,000.		4,000,000	31.30
6. (a) Depreciation at 10 per cent on plant Rs. 87,000,000. (b) Depreciation at 5 per cent on Building Rs. 10,000,000. (c) Insurance @ $\frac{1}{4}$ per cent on Rs. 102,000,000.	8,700,000 500,000 250,000		

	Rs.	Say Rs.	Per ton
(d) Interest on Working Capital @ 6 per cent. on Rs. 5,000,000.	300,000	10,750,000	84.00
7. Capital charges, Miscellaneous items, Township charges.	1,271,000 260,000	1,531,000	12.00
		43,091,000	336.84
8. Less, Credit for surplus steam @ Rs. 3/1000 lbs. . .	670,000	5.24	
	42,421,000	331.60	

∴ Cost per ton of NH₃ = Rs 331

Capital charge @ 12 per cent. on Rs. 97,000,000 or per ton Rs. 76 = Rs. 331 + Rs. 76
= Rs. 407



VIII. Cost of Production of Urea (Prilled)

		Rs.
<i>Investment</i>	.. Plant ..	33,000,000
	Building ..	4,000,000
	Working Capital ..	<u>2,000,000</u>
		<u><u>39,000,000</u></u>

Yearly capacity : 90,000 tons or per day : 272 tons.
per hr. : 11.3 tons.

		Rs.	Per ton
1.	Ammonia @ 0.6 T/ton urea @ Rs. 407 ..	22,000,000	244.0
2.	Power @ 290 Kwh/ton urea @ 8 nP./unit ..	2,080,000	23.2
3.	Steam 2.6 T/ton urea @ Rs. 3/ton ..	700,000	7.8
4.	Water 2000 Gal./ton @ 0.50/1000 Gal. ..	90,000	1.0
5.	Labour, supervision and over-heads ..	800,000	9.0
6.	Maintenance, supplies and all other expenses @ 6 per cent. on Rs. 37,000,000.	2,220,000	24.7
7.	Depreciation @ 10 per cent. on Plant Rs. 33,000,000 ..	3,300,000	36.7
8.	Depreciation @ 5 per cent. on Building Rs. 4,000,000.	200,000	2.2
9.	Insurance @ $\frac{1}{4}$ per cent. on Rs. 37,000,000 ..	92,500	1.1
10.	Interest on Working Capital @ 6 per cent. on Rs. 2,000,000.	120,000	1.3
11.	Shares of Miscellaneous Expenses ..	484,000	5.4
12.	Share of Township Expenses ..	100,000	1.1
		<u><u>32,186,500</u></u>	<u><u>357.5</u></u>

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Say 32,190,000

∴ Cost per ton = Rs. 358
12 per cent. return on block of = Rs. 36.8 per ton.
Rs. 37,00,000.

Packing = Rs. 25 per ton.
Average Transport = Rs. 20 per ton.

Rs. 439.8 say Rs. 440 per ton.

(Carbon dioxide will be available from Ammonia Plant which will be more than adequate both for urea and ammonium sulphate requirements).

(Rate of supply of urea to Co-operative Societies as fixed by Government was Rs. 720 per ton in the year 1959).

IX. Cost of Production of Ammonium Phosphate (11:48) (Granulated)

Investment —

	Rs.
Plant	26,000,000
Building	3,000,000
Working Capital	10,000,000
	<hr/>
	39,000,000

Capacity 125,000 tons/year or 380 tons/day or 15.8 tons/hr.

Yearly Cost—

	Rs.	Per ton
1. Ammonia 0.144 per ton of Ammonium Phosphate @ Rs. 407/ton.	7,360,000	59.7
2. Phosphate Rock (29.5 per cent P ₂ O ₅) @ Rs. 100 per ton 222,000 tons.	22,200,000	177.5
3. Sulphur 57,000 tons @ Rs 160 per ton	9,120,000	73.0
4. Power @ 125 units / ton @ 8 nP. per unit	1,250,000	10.0
5. Steam and fuel Rs. 4 per ton	500,000	4.0
6. Water : 4000 gallons / ton @ 50 nP. / 1000 Gal.	250,000	2.0
7. Labour, supervision and over-heads	1,000,000	8.0
8. Maintenance, supplies, all other services and miscellaneous expenses @5 per cent. on Rs. 29,000,000.	1,450,000	11.6
9. Depreciation on Plant @ 10% on Rs. 26,000,000	2,600,000	20.8
10. Depreciation on Building @ 5 % on Rs. 3,000,000	150,000	1.2
11. Insurance @ 1/4 per cent. on Rs. 29,000,000	72,500	0.8
12. Interest @ 6 per cent. on Rs. 10,000,000	600,000	4.8
13. Miscellaneous charges, allocation	380,000	3.0
14. Township expenses, allocation	100,000	0.8
	<hr/>	<hr/>
	47,032,500	377.2
Less, Credit for Steam	1,030,000	8
	<hr/>	<hr/>
	46,002,500	369.2
		Say 369.0
12 per cent. return on block of Rs. 29,000,000	Rs. 28 per ton	
Packing	Rs. 20 per ton	
Average Transport	Rs 20 per ton	
	<hr/>	<hr/>
	Rs. 437 per ton	

(The selling price of Ammonium Phosphate is Rs. 750 per ton at the present time).

X. Cost of Production of Ammonium Sulphate

Investment—

		Rs.
Plant	.. ..	43,000,000
Building	.. ..	6,000,000
Working Capital and spares.		5,000,000
		<hr/>
		54,000,000

Capacity : 200,000 tons /year or 606 tons / day or 25.2 tons / hr.

Yearly Cost :—

	Rs.	Per Ton
1. Ammonia 56,000 tons @ Rs. 407 / ton ..	22,850,000	114.25
2. Gypsum from Ammonium Phosphate Plant .. ..	.. ..	..
3. Power @ 70 Kwh / tons product	1,120,000	5.60
4. Steam @ 1650 lbs / ton @ Rs. 3 / 1,000 lbs. ..	990,000	4.95
5. Water 4000 gallons / ton @ 0.50 per 1000 gal. ..	900,000	2.00
6. Labour, supervision and over-heads	1,000,000	5.00
7. Maintenance and supplies and all other services etc. 5 per cent. on Rs. 49,000,000.	2,450,000	12.50
8. Depreciation @ 10 per cent. on Rs. 43,000,000 on Plant ..	4,300,000	21.50
9. Depreciation @ 5 per cent. on Rs. 6,000,000 on Building. ..	300,000	1.50
10. Insurance @ 1/4 per cent. on Rs. 54,000,000 ..	135,000	0.65
11. Interest on Working Capital @ 6 per cent. ton Rs. 5,000,000.	300,000	1.50
12. Miscellaneous charges	642,000	3.21
13. Township expenses	100,000	0.50
	<hr/>	
	35,087,000	173.16
		say 173
12 % return on block on Rs. 49,000,000 or Rs. 29.4 / ton ..	..	say Rs. 30
Packing .. .. .. .. ..	.. ..	Rs. 20
Average Transport .. .. .. .. ..	.. .. .. .. ..	Rs. 20
		<hr/>
		Rs. 243 per ton

(1) Carbon dioxide gas would be available as a by-product from Ammonia Synthesis gas.

(2) Gypsum (Calcium Sulphate slurry) would be available from production of Ammonium Phosphate.

(Rate of supply of Ammonium Sulphate to Co-operative Societies as fixed by Government was Rs. 355 per ton in the year 1959).

CHAPTER VI

CONSIDERATION OF SUITABILITY OF DIFFERENT LOCATIONS

I. The Committee visited Cambay on 10th July 1960, Broach / Ankleshwar on 23rd July 1960 and Bhavnagar on 30th / 31st July 1960. The following facilities were studied to estimate the suitability of each location for the installation of the fertilizer plant.

(1) *Sites.* — their load-bearing capacities, approachability, availability and general suitabilities ;

(2) *Water.* — availability, cost and purity ;

(3) *Transport facilities.* — vicinity of the rail-head, port, approach-roads and highways ;

(4) *Labour.* — character and availability ;

(5) *Weather statistics.* — In the appendix to this report, average mean statistics (normals) for Bhavnagar, Baroda and Surat have been reproduced. These were secured from Colaba Observatory of Government of India. No average figures were available for Broach and Cambay. But it was indicated that the figures of Baroda should apply to Cambay and the mean of the figures of Baroda and Surat should apply to Broach (Ankleshwar).

As for power, as discussed earlier in the chapter No. 4 on facilities, no individual locations were studied separately. It is proposed that the Project should have its own independent power-house of 40,000 KW. The fuel for the power-house boilers, *viz.*, 92,000 tons coal will have to be procured from Madhya Pradesh or Vidarbha coal fields until fuel oil becomes available locally when the boilers could be switched over to fuel oil, if the rates are economic. The transport of coal to Cambay and Ankleshwar locations would be by broad gauge railway line. The supply to Bhavnagar from the same source would, however, involve transhipment to meter gauge railway. In case Tarapore-Bhavnagar broad gauge link materialises soon, Bhavnagar will also get coal by broad gauge. The facilities for the disposal of effluents exist at all the three locations.

II. Sites. — All the three locations have sites suitable for the installation of the fertilizer plant; the requirement of about 400 acres for locating the plant, and, if required, 600 acres for township will be available. These are indicated by rectangular parts on maps of individual locations annexed herewith :—

(1) *Bhavnagar.* — At Bhavnagar, a suitable site would be near the air-port. The railway line and the port would also be close-by. The land is flat and the sub-soil is rocky permitting heavy structures.

(2) *Broach-Ankleshwar.* — A suitable site at this location would be at a high level point on a rocky ridge on the South bank of river Nerbada. The site would be near the National Highway, the Rajpipla road and the Railway. The site is situated within 10 miles of the Hajat Oil Field.

(3) *Cambay*. — The site at Cambay is situated on the North of the Khar lands of the mouth of Mahi-Sagar. The site is situated at a fairly high level rising northward from the Khar lands. The required area will be available at this site. The Railway is also nearby.

III. Water :—

(1) *Bhavnagar*. — At Bhavnagar, ample supplies of water could be made available from the proposed canal of Shetrunji Dam. It has been estimated that the output of water in the canal at this end would be of the order of 20 million gallons per day. This supply, it is learnt, has been earmarked for the Bhavnagar Municipality for town supply and supply to industries. It is likely that the canal would be ready to deliver these water supplies by the time the plant goes into operation.

(2) *Broach (Ankleshwar)*. — The site mentioned above at the Broach-Ankleshwar location is situated at a distance of about 8 miles from Shuklatirth which is the upstream point free from the effects of tidal range. In fact, the new water supply system for the Broach City is deriving water from this point. Regarding the supply to the fertilizer factory, there should be no difficulty quantity-wise or quality-wise to obtain fresh water from the source. An adequate pipeline will have to be laid from Shuklatirth South bank to the proposed site as the present pipeline from Shuklatirth to Broach is designed only for about 3 million gallons of water per day. Taking into account the level gradient from Shuklatirth to Broach, water will flow by gravity.

(3) *Cambay*. — At Cambay, availability of water would present some difficulty. The proposed site is situated in an area which is very much in the proximity of the Khar lands ; consequently any system of deep tubewells may not prove useful. Another alternative would be to form a water grid by putting tubewells in the area of Virsad-Dharmaj situated at a distance of about 12 miles away from Cambay. Fresh water will be available from this system and pipeline will have to be laid for bringing fresh water to Cambay in the required quantities.

IV. Transport :—

(1) *Bhavnagar*. — Presently meter gauge railway connection is available at site ; broad gauge railway link from Tarapore to Bhavnagar is proposed for the Third Five Year Plan. The concrete jetty at the port with direct berthing of steamers handles traffic of three lakh tons per year. A lockgate under construction is expected to be ready next year and will help to handle a million ton of cargo at this port. The crane facilities are being modernised and augmented to attain this goal. In view of this, Bhavnagar presents the required facility in handling the imported raw materials such as sulphur, rock phosphate and naphtha. For distribution of the products, there is a highway connecting Bhavnagar with Ahmedabad on one side and rest of the Saurashtra *viz.*, Rajkot on the other.

(2) *Broach (Ankleshwar)*. — The proposed site at this location is served by the broad gauge railway line on the one hand and the National Highway on the other. It may also be possible to develop inland port facilities in a limited way. In this case, the raw materials, *viz.*, coal, sulphur and rock phosphate will have to be transported from Bombay by the Western Railway.

As far as the transport of light naphtha is concerned, the location offers an attractive possibility of bringing by pipeline the natural gas, the waste gas, reformed gas or light naphtha from the refinery likely to be constructed near Hajat.

(3) *Cambay*. — Cambay is a terminal of the broad gauge railway line from Anand. As port facilities are not available at present, the imports of raw materials will have to be by rail. The facilities for the mineral oils and/or gas will be similar to those described for Broach (Ankleshwar).

V. Labour :— At all the three locations, the labour and personnel required for the fertilizer plant would be available in view of the proximity of the townships and in view of the un-employment or the under-employment existing at either of the locations. The vicinity of the centres of higher educations, *viz.*, Colleges, Agricultural Schools and Industrial Training Centres will also provide the required skilled labour and administrative staff.



CHAPTER VII

COKE AND GAS — ALTERNATIVE RAW MATERIALS FOR NITROGENOUS FERTILISERS

7.1. A large quantity of coke is being consumed for the manufacture of soda ash at present. This is perhaps one of the most important uses of coke in the State. Another and apparently larger use is for the operation of foundries. The target of production for soda ash in the country is 4,50,000 tons in 1965. It is likely that a large portion of the increased production of soda ash will be in Saurashtra in Gujarat. The consumption of coke by soda ash and other plants in Gujarat is estimated at about 1,00,000 tons by 1965. It is the set policy of the Government of India to encourage the manufacture of plant, machinery, etc., indigenously and it is planned that by the end of 1965, India should be able to manufacture at least 80 per cent. of its requirements of capital goods. Because of this, it is very likely that there will be a big increase in foundries, engineering workshops, etc., in the Gujarat area. It is estimated that the probable consumption of coke for this purpose might be of the order of 1,000 tons/day. The coke required for the Gujarat area will have to be transported from coke-oven plants located in coal-fields of Bengal, Bihar, Madhya Pradesh and Vidarbha. Coke is bulkier than coal. As a result, the same wagon capacity holds less weight of coke than coal. Besides, on an average, about one and a half times as much coal by weight is needed for the production of coke. With the present freight structure, the cost of freight for transporting an adequate quantity of coal to produce a stated quantity of coke will, therefore, not be very appreciable, since by-products will be available in the processing of the coal and the advantages will greatly outweigh the slightly higher expenditure on freight. It would, therefore, be an attractive proposal to produce coke on the spot where it is consumed and secure important by-products for ancillary industries.

Well-integrated synthetic dyes and drugs-plants are located in Gujarat. It is likely that these plants will expand considerably in future. Some more new plants will also be located in Gujarat. Some of the important raw materials required for the operation of these plants will be available from the by-products of a coke-oven plant. Prima facie, therefore, it appears to the Committee that it might be advantageous to erect a coke-oven plant at a suitable place in Gujarat with the purpose of manufacturing coke, recovering by-product chemicals required for the consumer intermediate industries in Gujarat and utilising coke-oven gas for the production of nitrogenous fertilizers. At a later stage, the Committee proposes to study this and prepare a detailed report.

7.2. Ammonium Chloride as a Nitrogenous Fertilizer.— The Committee also considered feasibility of the manufacture of ammonium chloride fertilizer in a modified Solvay process. Under such a project, along with ammonium chloride, an identical quantity of soda ash would be produced. The Committee felt that at this stage, it would be immature to consider using ammonium chloride for Gujarat soils and hence, it would not be worthwhile pursuing this project at present.

CHAPTER VIII

SUMMARY

The Fertilizer Production Committee consisting of :—

- | | | |
|--|-------------|------------|
| (1) Shri V. Isvaran, I. C. S., Chief Secretary to the Government of Gujarat. | .. .. .. .. | Chairman. |
| (2) Shri M. G. Monani, I. C. S., Secretary to the Government of Gujarat, Legal Department (Industry ) | .. .. .. .. | Member. |
| (3) Dr. L. A. Bhatt | .. .. .. .. | Member. |
| (4) Dr. M. D. Parekh | .. .. .. .. | Member. |
| (5) Dr. R. K. Trivedi | .. .. .. .. | Member. |
| (6) Dr. C. B. Patel, Director of Industries | .. .. .. .. | Secretary. |

studied the project for the installation of a Fertilizer Plant at a suitable location in Gujarat. Following are the salient features of the investigations carried out by the Committee :—

(1) **Capacity of the Plant.**— It is recommended that the production of the fertilizer plant should have the capacity of 96,000 tons of nitrogen per year. This capacity has been arrived at as a result of the study of crop pattern, soils and preferences of cultivators for fertilizers.

(2) **Pattern of Production.**— On the basis of the requirements and study mentioned above, it is recommended that 96,000 tons of Nitrogen be produced as follows :—

Annual Nitrogen tonnage.	As	Annual Products tonnage.
40,000	Urea	90,000
14,000	Ammonium Phosphate	125,000
42,000	Ammonium Sulphate	200,000
96,000		415,000

(3) **Raw materials.**— Raw materials required for the above production would be :—

- (i) Light Naphtha 1,14,000 tons per annum or its equivalent amount in the form of natural gas, waste gas, reformed gas, bunker 'C' oil or crude oil ;
- (ii) Sulphur 57,000 tons per year ;
- (iii) Rock Phosphate 2,22,000 tons per year ; and
- (iv) Coal 92,000 tons per year (or equivalent quantity of fuel oil).

(4) **Probable selling price of finished goods.**—On the basis of the study, the probable wholesale selling prices of the various finished products could be indicated as :—

- | | |
|--------------------------|--------------------------|
| (i) Urea | .. Rs. 440 per ton : |
| (ii) Ammonium Sulphate | .. Rs. 243 per ton ; and |
| (iii) Ammonium Phosphate | .. Rs. 437 per ton. |

It may be mentioned that these figures include averaged transport cost and 12 per cent. return on the Block Investment.

As against the above estimated selling prices, we have to view the existing selling prices to Co-operative Societies :—

- | | |
|--------------------------|----------------------|
| (i) Urea | .. Rs. 720 per ton ; |
| (ii) Ammonium Sulphate | .. Rs. 355 per ton ; |
| (iii) Ammonium Phosphate | .. Rs. 750 per ton. |

(5) **Capital Cost.**—The capital cost of the project, including site facilities, power plant, township, and plant erected ready for operation is estimated at Rs. 28.2 crores.

(6) Requirements :—

- | | |
|---------------|--|
| (1) Land | .. 400 acres for the factory site and 600 acres for the township (if required) ; |
| (2) Water | .. 8 million gallons per day ; |
| (3) Personnel | .. Management and operatives — 3,000. |

(7) **Location.**—The Committee recommend the following 3 possible locations :—

- (1) Bhavnagar ;
- (2) Broach-Ankleshwar, and
- (3) Cambay.

(8) **Processing of Project.**—In case this project is to be undertaken by private sector, the Committee feels that in order to bring the same into production in the shortest possible time, Government of Gujarat may render the following assistance to the parties concerned :—

- (a) Help in acquiring necessary land ;
- (b) Help in acquiring necessary rights for laying pipe lines for water, oil, gas, effluents, etc.
- (c) Help in providing of railway siding and approach-roads and such other communications.
- (d) Help in getting enough water at cost.

(9) **Future Plants.**—The present report has recommended one fertilizer unit to start with. It is, however, strongly recommended that in order to meet the growing requirements of fertilizers in Gujarat, another unit could be installed at an appropriate location, producing coke and fertilizers based on coke-oven gas. The Committee proposes to include this in a subsequent report.



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APPENDIX

Analysis of soils of Gujarat

Soils	Amreli					Gandevi
	1	2	3	4		
1. Coarse sand	4.21	0.42	0.74	5.07
2. Fine sand	33.78	80.07	76.57	34.56
3. Silt	23.50	10.75	8.25	22.90
4. Clay	21.35	5.50	11.25	20.00
5. Moisture	8.42	1.22	2.20	3.33
6. Calcium Carbonate	9.42	..	0.26	11.90
7. Nitrogen	0.068	0.047	0.053	0.053
8. pH	8.50	8.20	7.80	8.80
9. Acid Insoluble matter	49.34	85.72	89.46	68.51
10. Total K ₂ O	0.042	0.276	0.120	0.406
11. Total P ₂ O ₅	0.065	..	0.139	0.071
12. Available K ₂ O	0.0118	0.0262	0.0130	0.0174
13. Available P ₂ O ₅	0.0034	..	0.0170	0.0014
14. C/N Ratio	9.50	..	9.80	9.70
						10.20

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from typical locations.

Karjan	Kosamba	Mehsana	Navsari	Surat	Dabhoi	Harij
6	7	8	9	10	11	12
0.22	0.89	44.97	0.11	0.20	..	..
49.08	37.79	30.26	21.05	26.34	41.41	76.60
27.80	17.00	5.42	21.32	34.81	18.20	6.20
9.25	37.60	7.82	44.87	38.65	35.65	9.35
4.45	5.79	1.26	9.72	..	5.02	1.59
..	0.21	8.25	0.11	0.75	..	..
0.062	0.034	0.067	0.050	0.040	0.033	0.036
7.80	7.20	8.50	7.90	..	8.00	7.50
65.95	78.64	83.22	60.30	60.20	81.80	86.71
0.110	0.148	0.212	0.205	0.280	..	..
0.107	..	0.141	0.141	0.070
0.0060	..	0.0173	0.0093
0.0085	0.012	0.0376	0.0035
9.80	10.50	9.80	10.50



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APPENDIX III

Climatic data of the Locations considered

Monthly Means of Daily Maximum and Minimum Temperatures etc. for Bhavnagar (Saurashtra).

Month in the year	Mean of daily tempera-tures in °F		Mean of the		Mean of Rela-tive Humidity per cent.	Mean of monthly rainfall in inches
	Maximum	Minimum	Highest temperature in month of °F	Lowest temperature in month of °F		
January	..	84.0	54.0	91.6	44.4	F. N. 49 A. N. 26
February	..	87.3	57.6	96.4	47.0	F. N. 49 A. N. 24
March	..	95.7	65.6	104.1	55.2	F. N. 50 A. N. 22
April	..	102.0	73.5	108.5	65.9	F. N. 53 A. N. 21
May	..	105.2	78.1	111.6	72.4	F. N. 64 A. N. 33
June	..	99.8	80.2	107.6	74.8	F. N. 70 A. N. 47
July	..	92.9	78.4	99.9	74.5	F. N. 79 A. N. 62
August	..	90.9	76.6	96.5	73.8	F. N. 80 A. N. 60
September	..	92.4	74.9	98.4	71.4	F. N. 78 A. N. 55
October	..	95.8	70.7	100.1	64.2	F. N. 62 A. N. 34
November	..	90.7	62.6	96.0	54.4	F. N. 52 A. N. 25
December	..	85.1	55.7	90.6	47.4	F. N. 51 A. N. 27
						Total .. 22.58

F. N. denotes fore-noon 8-00 a.m.

A. N. denotes after-noon 5-30 p.m.

Note.— These figures have been supplied by the Office of the Director, Colaba Observatory, Indian Meteorological Department.

NORMALS REGARDING WIND FOR BHAVNAGAR (SAURASHTRA)

Month in the year	No. of days with wind force			Percentage number of days of wind from								
	8 or more	4-7	1-3	0	North East	North	East	South East	South	South West	West	North West
January	..	F. N. 0 A. N. 0	0 1	24 30	7	8	3	1	2	2	9	21
February	"	F. N. 0 A. N. 0	0 0	25 28	3	10	4	1	2	6	23	44
March	"	F. N. 0 A. N. 0	0 1	30 29	1	12	3	1	2	5	3	6
April	"	F. N. 0 A. N. 0	1 2	28 28	1	12	2	0	1	7	19	51
May	"	F. N. 0 A. N. 0	0 15	30 16	1	3	1	0	1	3	48	21
Juno	"	F. N. 0 A. N. 0	1 14	28 16	1	1	1	1	6	27	37	17
July	"	F. N. 0 A. N. 0	1 12	30 18	0	0	0	0	1	3	19	6
August	"	F. N. 0 A. N. 0	0 7	31 24	0	0	0	1	4	6	58	16
September	"	F. N. 0 A. N. 0	0 1	28 29	2	6	1	1	0	10	38	21
October	"	F. N. 0 A. N. 0	0 1	25 29	6	12	9	4	3	10	39	38
November	"	F. N. 0 A. N. 0	0 0	22 29	8	13	10	3	3	19	28	18
December	"	F. N. 0 A. N. 0	0 0	22 31	9	7	5	1	1	6	16	49
					17	50	28	2	1	0	0	2
												0

F. N. denotes forenoon 8-00 a.m.

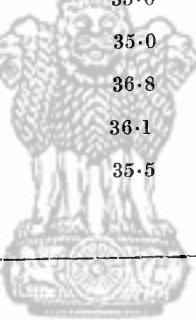
A. N. denotes afternoon 5-30 p.m.

Note.—These figures have been supplied by the Office of the Director, Colaba Observatory Indian Meteorological Department.

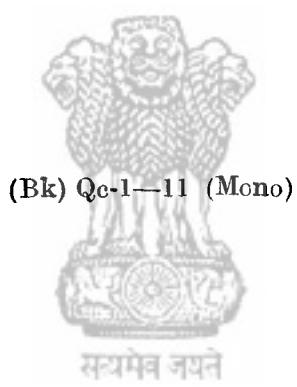
Wind force—
 1:—1 to 3 M. P. H.
 2:—4 to 7 M. P. H.
 3:—8 to 12 M. P. H.
 4:—13 to 18 M. P. H.
 5:—19 to 24 M. P. H.
 6:—25 to 31 M. P. H.
 7:—32 to 38 M. P. H.
 8:—39 to 46 M. P. H.

BROACH

Months	1958						Rainfall 1958	Rainfall 1957		
	Mean air temperature		Highest. Maximum	Lowest Minimum	In Degrees Centigrade	1.00 mm.				
	Maximum	Minimum								
January	..	33.2	14.8	36.7	11.2	1.00 mm.	00.8 mm.			
February	..	33.6	15.0	37.9	11.6	0.00	00.00			
March	..	37.8	20.2	42.8	13.9	1.00	00.00			
April	..	40.0	24.9	44.4	20.6	0.00	trace			
May	..	40.0	27.8	45.6	25.6	0.00	00.00			
June	..	36.5	27.3	39.5	22.8	69.8	192.6			
July	..	32.2	26.3	36.1	24.8	232.6	280.9			
August	..	32.2	25.2	35.0	23.3	331.8	236.0			
September	..	31.2	24.8	35.0	22.5	384.0	14.8			
October	..	34.6	22.6	36.8	17.2	85.1	trace			
November	..	34.1	18.3	36.1	14.2	10.8	trace			
December	..	32.3	14.9	35.5	8.9	0.00	0.00			
						1,116.1 mm.	725.1			



सत्यमेव जयते



(Bk) Qc-1—11 (Mono)

सत्यमेव जयते

Surat

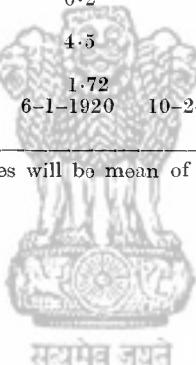
TABLE

(A port town on river Tapti.)

Ht 12 meters

Element			January	February	March	April	May
Pressure P ₁ P ₁ Milli bars	..	..	1,014.2	1,013.0	1,010.9	1,008.5	1,006.5
Max. temp. ° C	..	..	30.4	31.9	35.6	37.3	36.3
Min. temp. ° C	..	..	14.3	15.6	19.4	23.2	26.1
Vapour Pressure milli bars	..	..	12.3	13.6	17.8	23.7	28.1
Relative Humidity %	..	..	59	60	60	62	66
Rainfalls.—							
in mms.	..	..	2.8	2.0	0.3	0.8	6.1
in inches	..	..	0.11	0.08	0.01	0.03	0.24
Rainy days in the year	..	..	0.2	0.2	0.1	0.01	0.3
Wind speed KM/HR.	..	..	4.5	5.1	5.3	6.8	10.6
Heaviest rainfall in 24 hours in inches during last 65 years, on	..	..	1.72 6-1-1920	1.5 10-2-1898	.23 3-3-1904	1.26 30-4-1901	1.92 10-5-1917

Note.— Broach-Ankleshwar figures will be mean of those at Surat and Baroda.



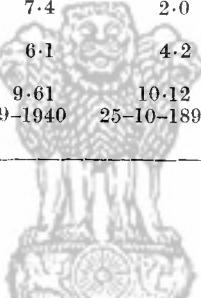
सत्यमेव जयते

I

(Height over sea level)

1940 normals (8--30 Hours I. S. T.)

June	July	August	September	October	November	December	Year
1,002.2	1,001.1	1,003.4	1,006.7	1,010.1	1,012.7	1,014.2	1,008.6
33.8	30.7	30.3	31.5	34.5	33.3	31.1	33.1
26.6	25.4	25.0	24.4	22.3	18.3	15.2	21.3
30.9	31.1	29.9	29.0	23.8	16.5	13.2	22.5
74	83	82	81	68	58	58	68.00
218.9 8.62	442.5 17.42	189.2 7.45	147.3 5.8	38.3 1.51	8.1 0.32	2.0 0.08	1,058.3 41.67
8.0	16.3	12.4	7.4	2.0	0.5	0.1	47.6
11.9	11.7	9.5	6.1	4.2	4.5	4.3	7.0
10.24 27-6-1922	18.00 28-7-1891	9.1 2-8-1933	9.61 20-9-1940	10.12 25-10-1894	3.07 22-11-1912	1.66 20-12-1933	



सत्यमेव जयते

NORMALS

*Monthly Means of Daily Maximum and Minimum Temperatures
etc. for Baroda.*

Month in the year	Mean of daily air temperature in °F.			Mean of the highest temperature in month of		Mean of Relative Humidity percent.	Mean of monthly rainfall in inches
	Maximum	Minimum		°F	Lowest temperature in month of		
January	86.3	42.6	93.5	38.9	F. N. 61 A. N. 29	00.6
February	89.4	54.8	97.0	44.0	F. N. 61 A. N. 24	0.021
March	96.1	59.9	103.9	50.0	F. N. 50 A. N. 14	00.2
April	102.9	68.8	109.1	58.9	F. N. 50 A. N. 16	0.20
May	104.6	77.7	110.4	68.9	F. N. 67 A. N. 30	0.20
June	97.7	79.8	104.6	74.1	F. N. 79 A. N. 54	6.41
July	89.8	77.6	96.8	74.0	F. N. 88 A. N. 72	12.23
August	89.6	76.6	94.3	73.9	F. N. 85 A. N. 64	9.02
September	90.6	74.6	96.8	69.5	F. N. 84 A. N. 60	5.96
October	95.4	66.1	100.0	57.9	F. N. 75 A. N. 48	1.76
November	91.5	57.3	95.8	49.4	F. N. 67 A. N. 48	0.80
December	87.2	51.3	91.6	43.4	F. N. 67 A. N. 41	0.02
					Total annual ..		36.69

F. N. denotes forenoon 8-00 a. m.

A. N. denotes afternoon 5.30 p. m.

Note.— These figures have been supplied by the Office of the Director, Colaba Observatory, Indian Meteorological Department.

Observation is in S. J. Science Institute. As such wind force figures will be low compared to outskirts of Baroda. But definitely low when applied to Cambay.

Baroda figures will provide approximate guide to Cambay figures. Average between Baroda and Surat figures will also supply approximate data for Broach.

NORMALS REGARDING WIND FOR BARODA.

(Bk) Qc-1—12 (Mono)

Month in the year	F. N. A. N.	No. of days with wind force*			Percentage No. of days of wind from								
		8 or more	4-7	1-3	0 Calm	North	North East	East	South East	South	South West	West	North West
January	..	0	0	19	12	19	27	2	0	3	1	2	6
	A. N.	0	0	23	8	26	14	2	1	3	5	5	16
February	..	F. N. A. N.	0	0	14	14	6	11	1	1	5	8	11
	A. N.	0	0	20	8	9	8	1	1	3	13	22	15
March	..	F. N. A. N.	0	0	21	10	12	10	1	4	7	13	11
	A. N.	0	0	26	5	12	6	1	5	3	17	22	16
April	..	F. N. A. N.	0	0	22	8	11	3	1	3	12	18	9
	A. N.	0	0	25	5	8	1	0	1	3	19	29	24
May	..	F. N. A. N.	0	0	29	2	4	1	1	1	4	55	19
	A. N.	0	1	29	1	2	0	0	1	6	40	31	16
June	..	F. N. A. N.	0	0	29	1	0	0	0	1	3	13	43
	A. N.	0	1	26	3	2	0	0	0	1	11	53	23
July	..	F. N. A. N.	0	0	29	2	0	0	0	0	1	65	22
	A. N.	0	0	29	2	1	0	0	0	0	9	62	18
August	..	F. N. A. N.	0	0	28	3	0	0	0	0	3	52	32
	A. N.	0	0	28	3	0	1	1	0	0	5	58	23
September	..	F. N. A. N.	0	0	22	8	4	1	0	0	3	26	25
	A. N.	0	0	22	8	2	1	1	0	1	5	32	20
October	..	F. N. A. N.	0	0	14	17	8	13	4	3	3	3	4
	A. N.	0	0	13	18	5	9	6	2	2	3	3	8
November	..	F. N. A. N.	0	0	10	22	6	17	7	2	1	0	0
	A. N.	0	0	8	22	8	9	3	1	0	1	1	5
December	..	F. N. A. N.	0	0	11	20	7	23	3	1	0	0	1
	A. N.	0	0	13	18	7	16	5	2	1	1	1	5

F. N. denotes forenoon 8-00 a. m.
A. N. denotes afternoon 5-30 p. m.

Wind forces.
1:-1 to 3 m/hr.
2:-4 to 7 m/hr.
3:-8 to 12 m hr.
4:-13 to 18 m/hr.

5:-19 to 24 m/hr.
6:-25 to 31 m hr.
7:-32 to 38 m hr.
8:-39 to 46 m hr.

Note.—These figures have been supplied by the office of the Director, Colaba Observatory,
Indian Meteorological Department.

Observation is in S. J. Science Institute. As such wind force figures will be low
compared to outskirts of Baroda. But definitely low when applied to Cambay.

APPENDIX IV

Plant and Raw Material Requirements.

1. Naphtha, Bunker oil or crude oil storage tanks.
2. Pumping house.
3. Selective Combustion Plant making CO₂, H₂ and N₂; heat exchange boilers.
4. Gas-cleaning and fractionating units.
5. Gas holders.
6. Cooling-tower and pump-house.
7. (a) Electrical distribution.
 (b) Structural steel work, including platform etc.
 (c) On site piping and itemised cost of any auxiliary equipment such as for central laboratory.
 (d) Effluent disposal plant.

Synthesis Gas Plant

1. Desulphurization.
- Desulphurization catalyst.
2. Raw gas compression.
3. (a) Carbon-di-oxide removal and recovery.
 (b) Purification of carbon-di-oxide for supply to urea and ammonium sulphate plant.
4. Carbon monoxide removal.
5. Cooling tower and pump-house.
6. (a) Electrical distribution.
 (b) Structural like platforms etc.
 (c) On-site piping and itemised cost of auxiliary equipment e. g. central laboratory etc.
7. Causticization plant.
 Effluent disposal unit.
 Copper liquor wash for Co-removal.
8. For 370 tons ammonia per day
 365 m. tons ammonia per day



Requirements : Daily 1.16 million cubic meter or 40 million cubic feet of synthesis gas.

Ammonia synthesis gas mixture with a composition of
 Hydrogen 75 per cent.
 Nitrogen 25 per cent.

Carbon monoxide less than 10 parts per million

Carbon-di-oxide less than 5 parts per million

Total of all oxygen compounds (Carbon monoxide, dioxide and water vapour)
 less than 20 parts per million.

Urea Plant

- (1) Carbon-di-oxide compression.
- (2) Ammonia supply tanks and pumps.
- (3) Urea synthesis.
- (4) Concentration and prilling.
- (5) Prilled urea storage
- (6) Bagging including empty bag storage
- (7) Cooling towers and pump house
- (8) (a) Electric distribution
 (b) Platforms and structural supports
 (c) On-site piping and auxilliary units

(9) Any special purification equipment to get the CO₂ to required purity to any special requirements.

(10) A section for production of technical grade urea

Specification of Prilled Urea	..	275 tons/day
Nitrogen content	..	46 per cent. wt./wt. minimum
Biuret	..	0.5 per cent. wt./wt. minimum
Moisture	..	0.5 per cent. wt./wt. minimum
pH. of 10 per cent. solution	..	between 7 and 8 minimum
Size range	..	85 per cent. between 1 mm. and 2 mm. size and not more than 5 per cent. below 1 mm.

Feed : 99.9 per cent. pure anhydrous liquid ammonia.

98.00 per cent. (Minimum) pure carbon-di-oxide gas free from organic and inorganic sulphur compound oxygen content should not exceed 0.5 per cent.

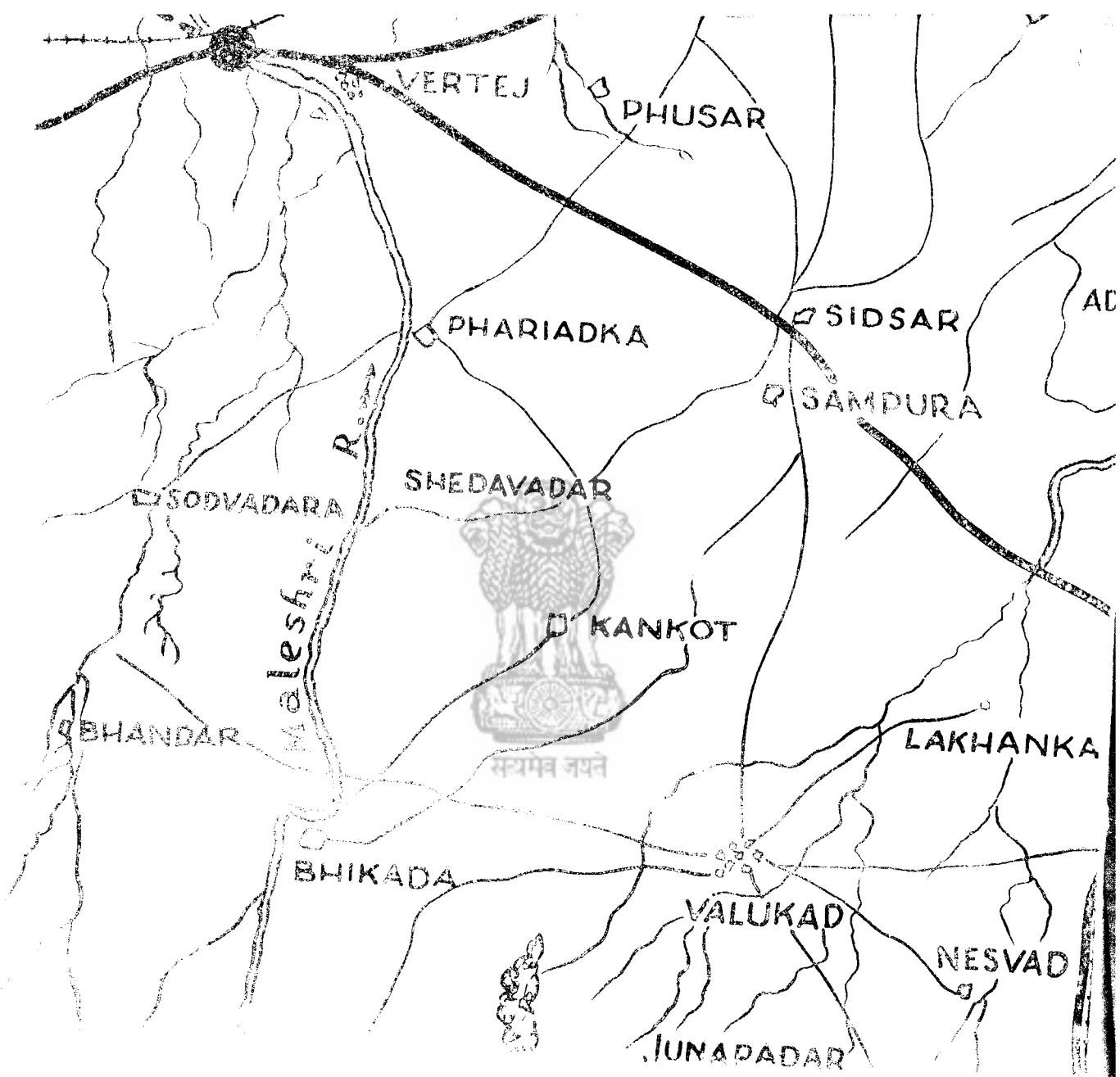
Technical grade Urea (10 tons per day):

Moisture	..	0.25 per cent. wt./wt. maximum
Ash	..	0.002 per cent. wt./wt. maximum
Total nitrogen	..	..
dry basis	..	64.50 per cent. wt./wt. minimum
Biuret	..	0.2 per cent. wt./wt. maximum
Free ammonia	..	0.01 per cent. wt./wt. maximum
pH. of 10 per cent. solution	..	between 7 and 8

Ammonium Phosphate Plant.

- (1) Rock Phosphate grinding and handling.
- (2) Sulphuric acid plant 500 tons/day capacity.
- (3) Waste heat boilers for high pressure steam.
- (4) Phosphoric acid unit.
- (5) Ammonia supply tanks and pumps.
- (6) Ammonium phosphate unit.
- (7) Concentration and granulation unit.
- (8) Pumping house for gypsum slurry to the ammonium Sulphate unit.
- (9) Ammonium phosphate bagging and store for empty bags.
- (10)
 - (a) Electrical distribution.
 - (b) Structural steel works, supports, platform etc.
 - (c) On site piping and
 - (d) Effluent disposal plant.





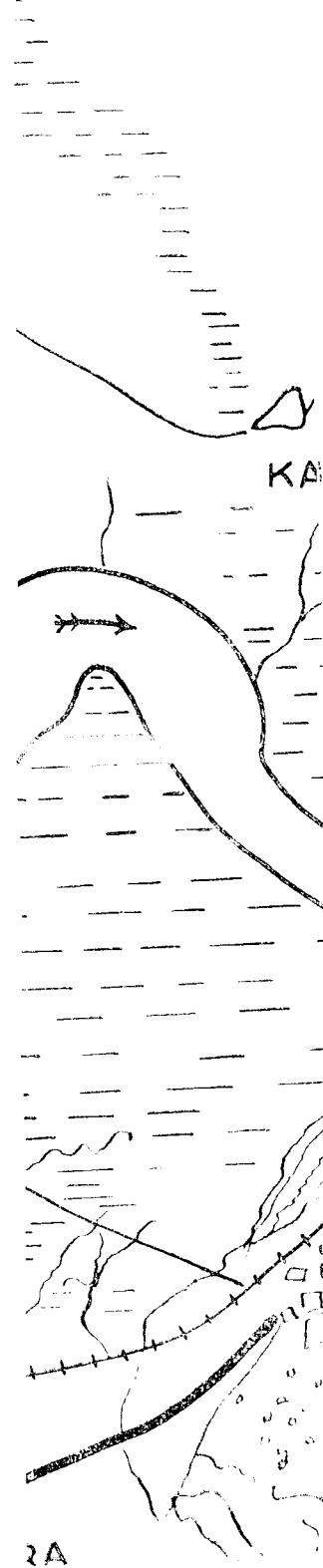
AREA AROUND BHAVNAGAR

SCALE:- 1 MILE TO AN INCH



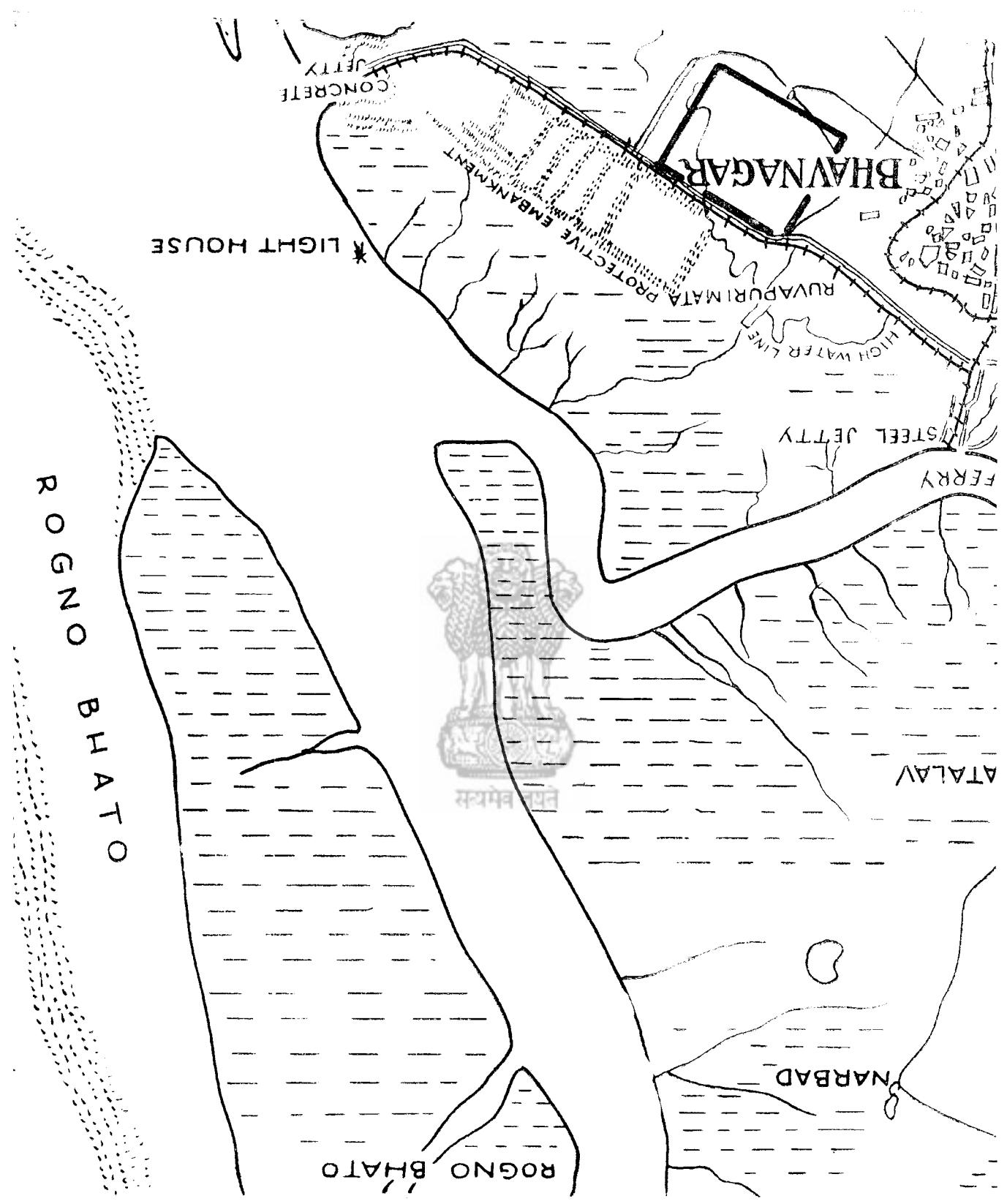
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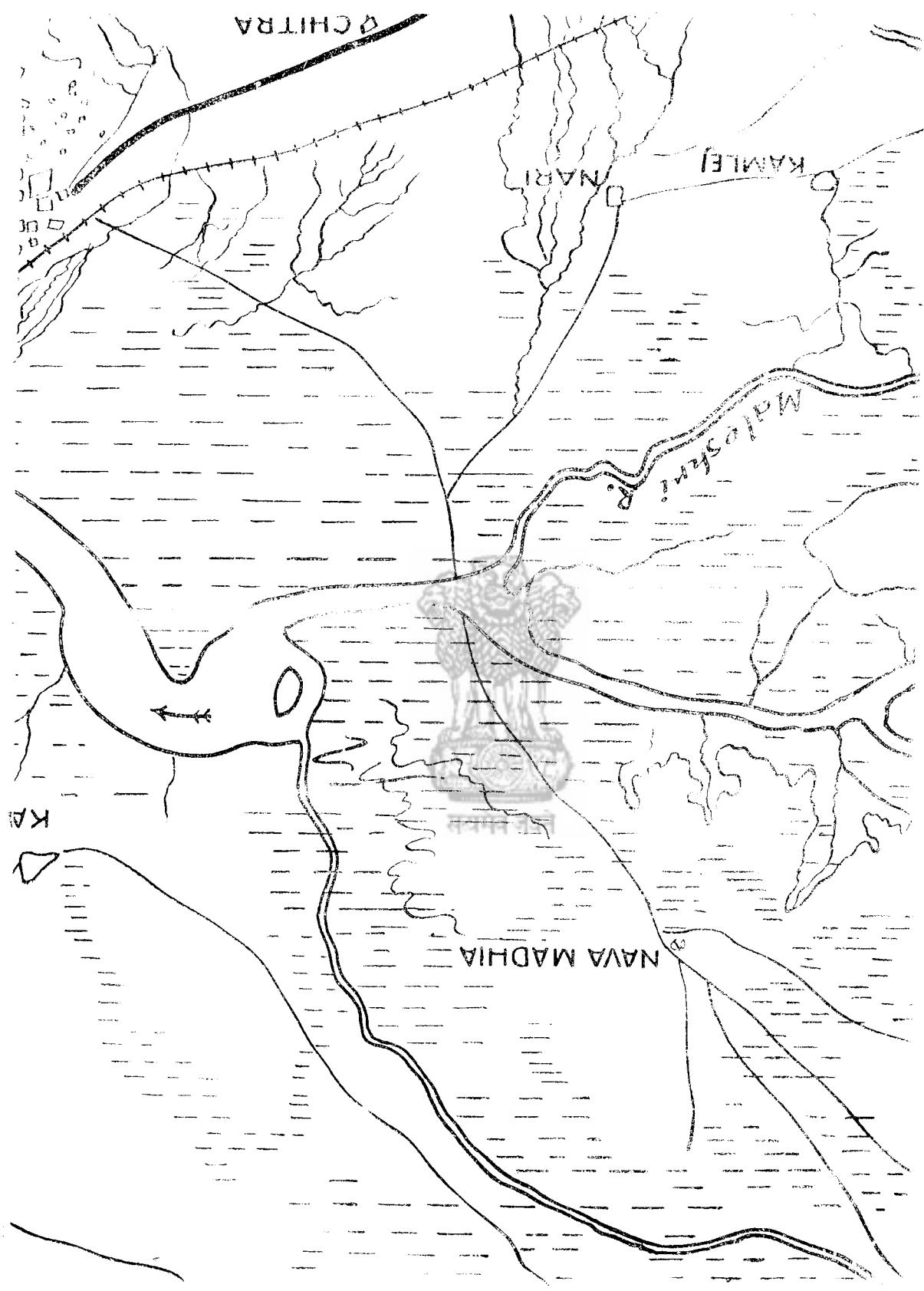
- | | |
|------------------------|--|
| 1. RAILWAYS SHOWN THUS | |
| 2. RIVERS | |
| 3. HILLS | |
| 4. LIGHT HOUSE | |
| 5. REEDS | |
| 6. PACCA ROADS | |
| 7. CUTCHA ROAD | |
| 8. BRIDGES | |

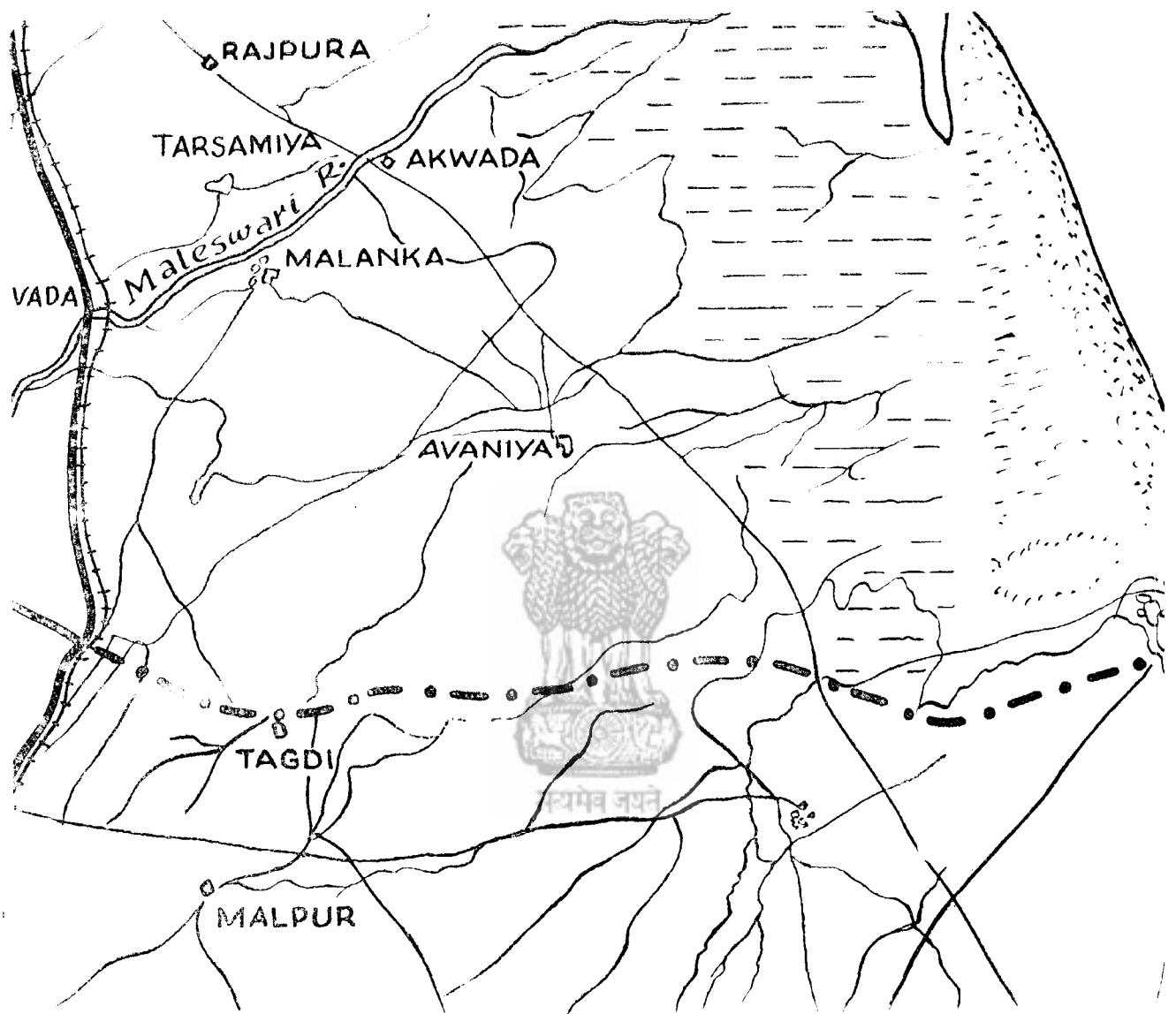


CHANNEL
MALCOLM'S

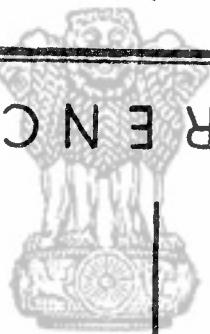
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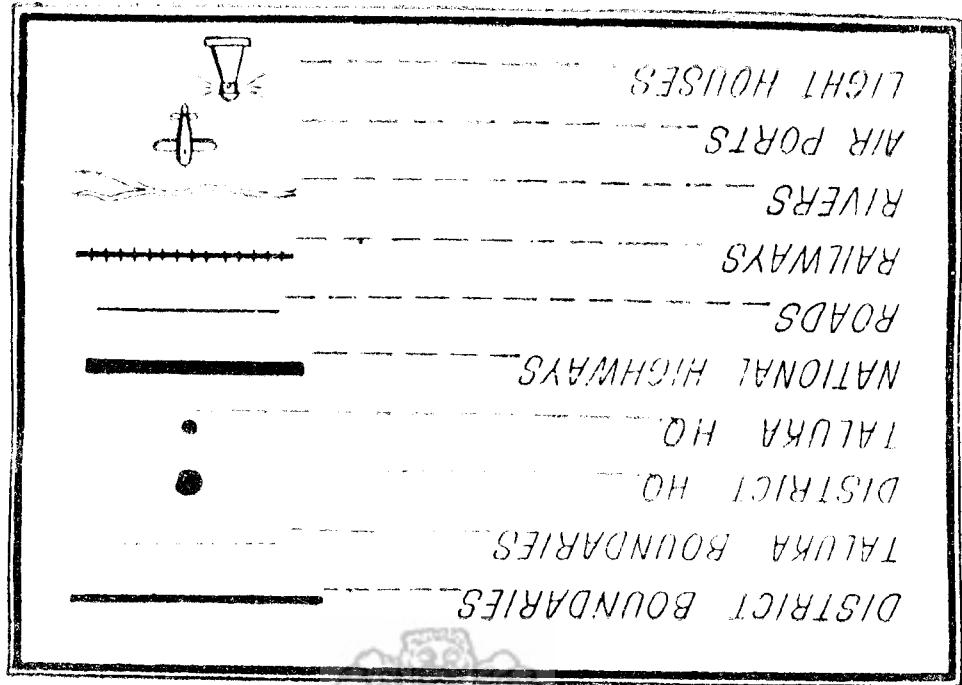


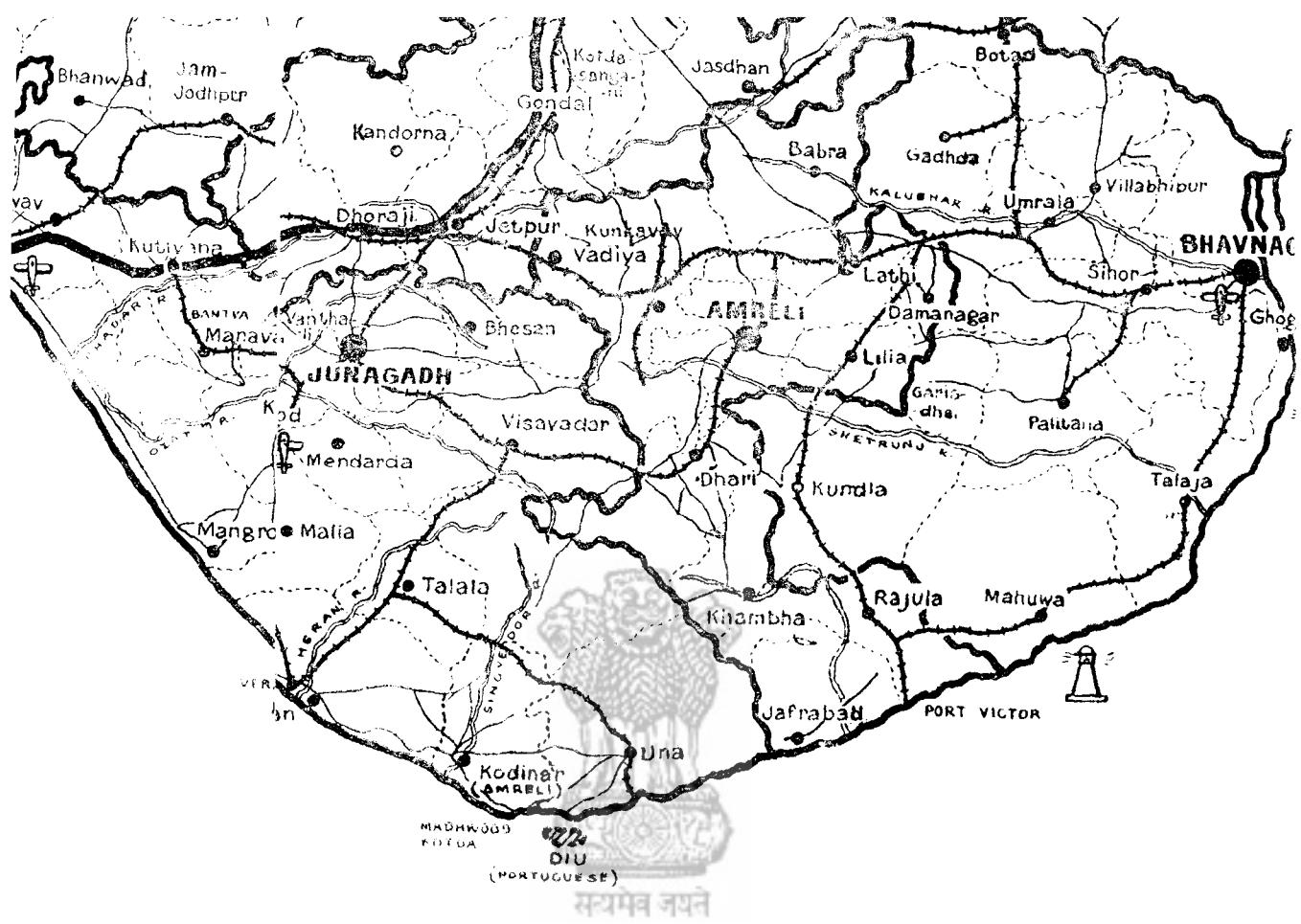


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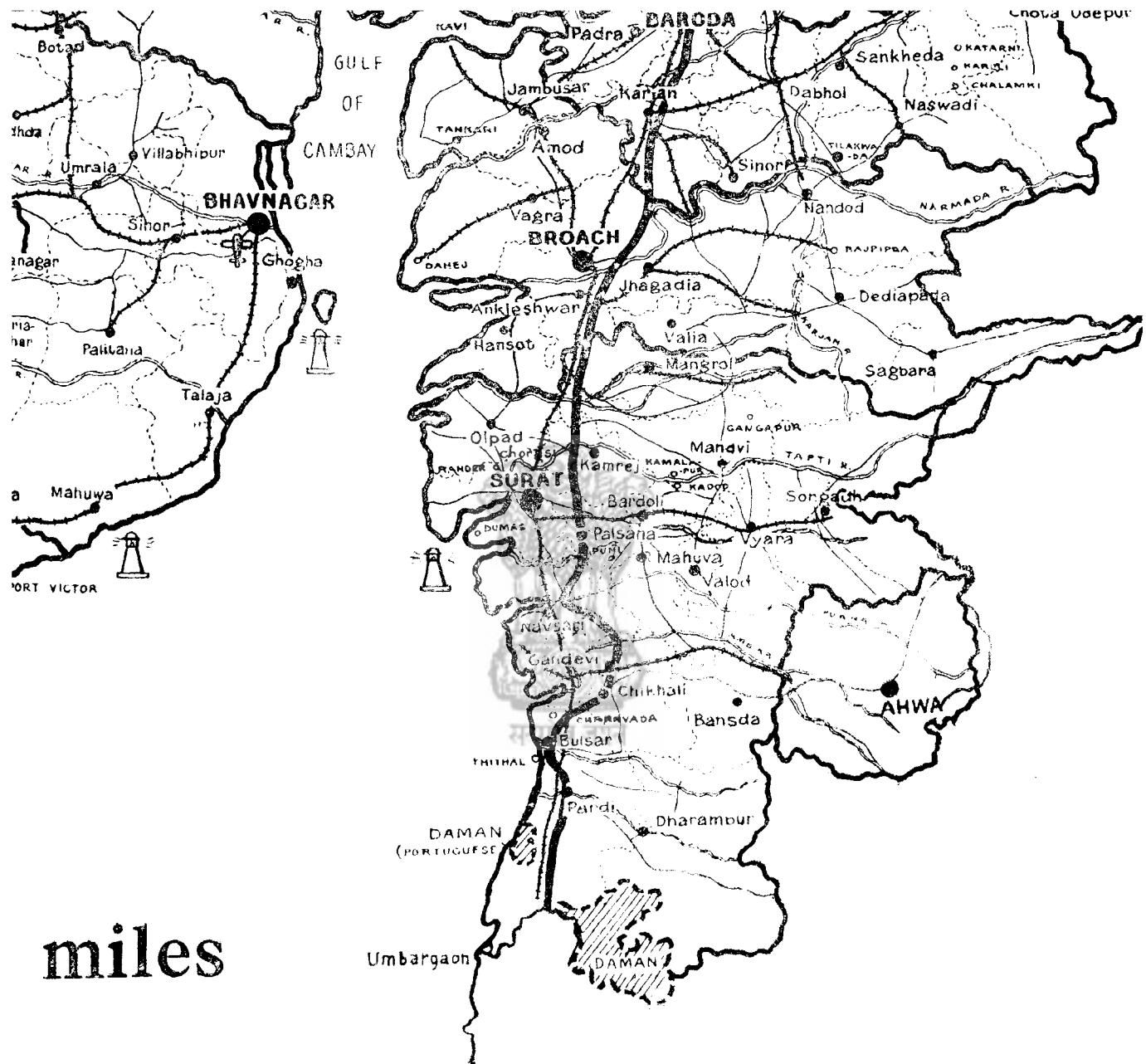


संघरेपन जनने

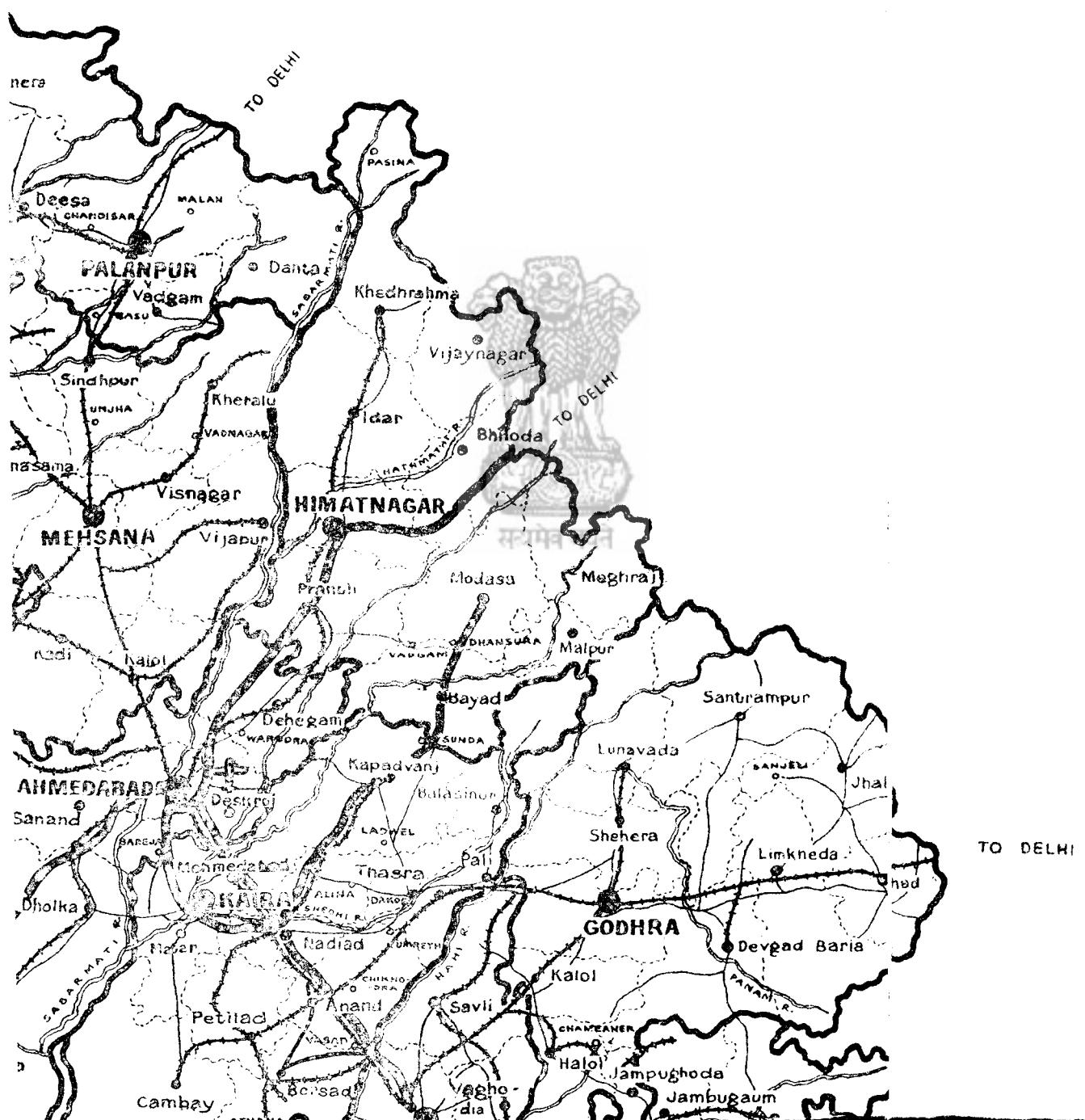




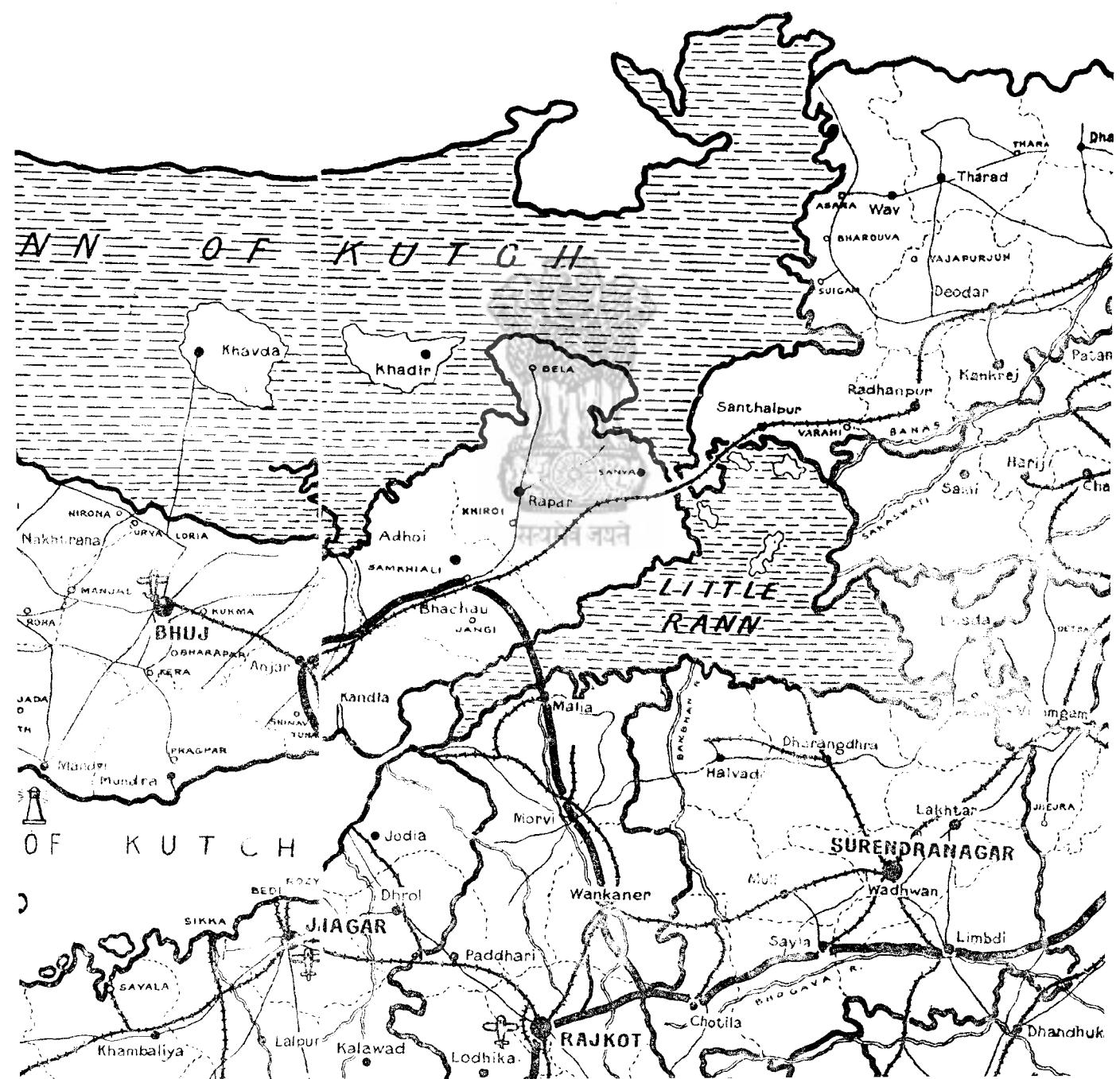
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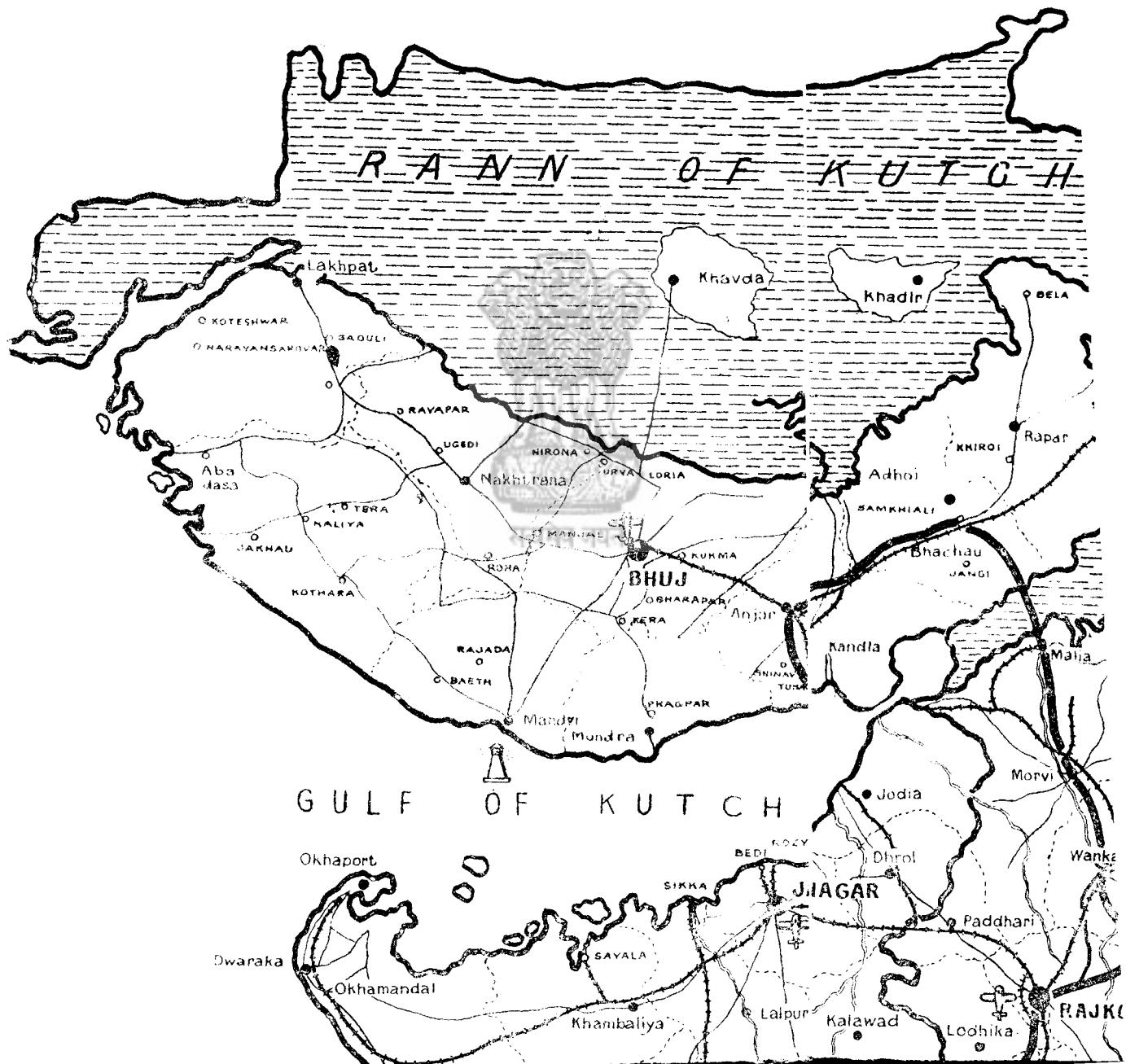
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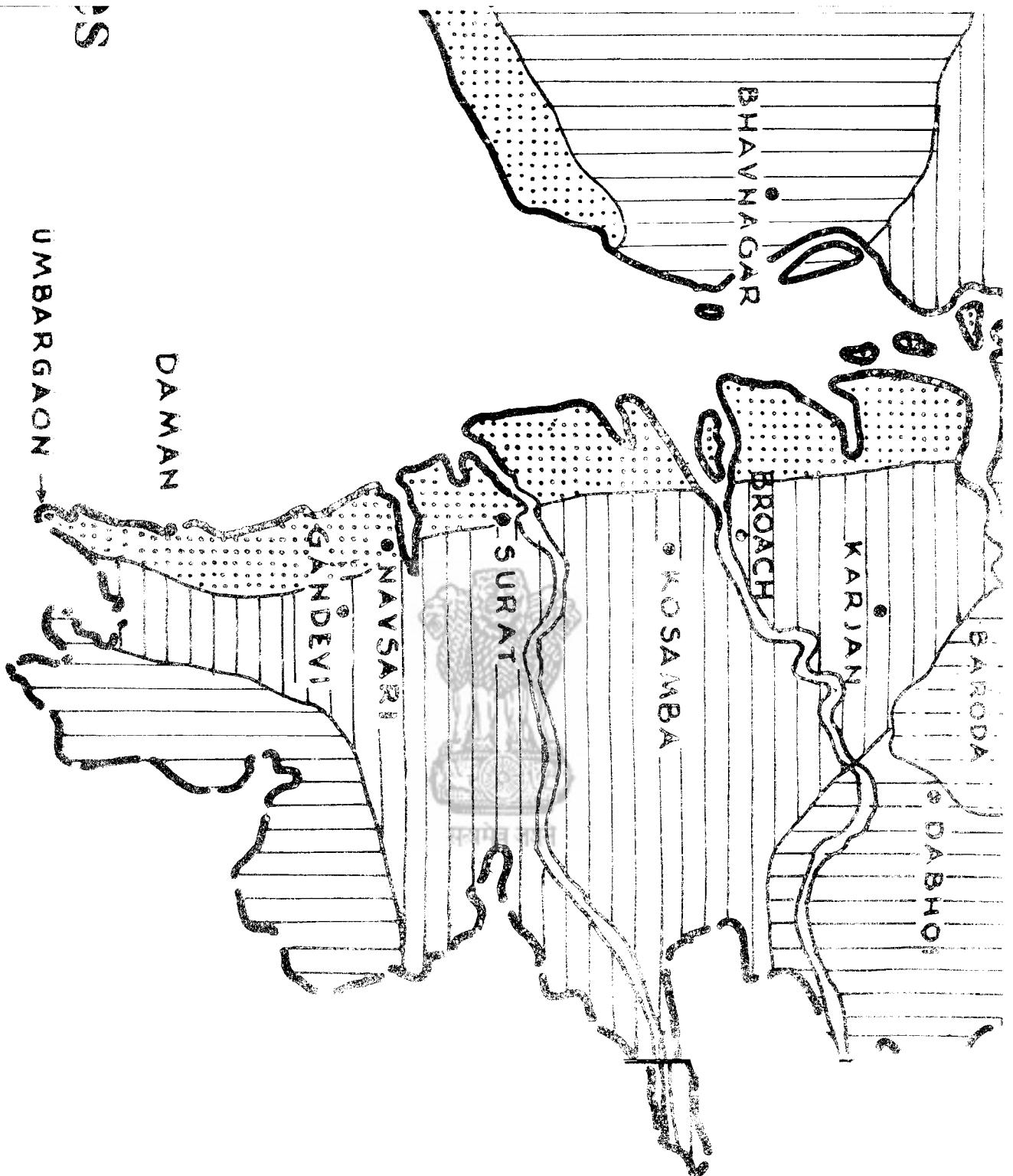


GUJARAT ST



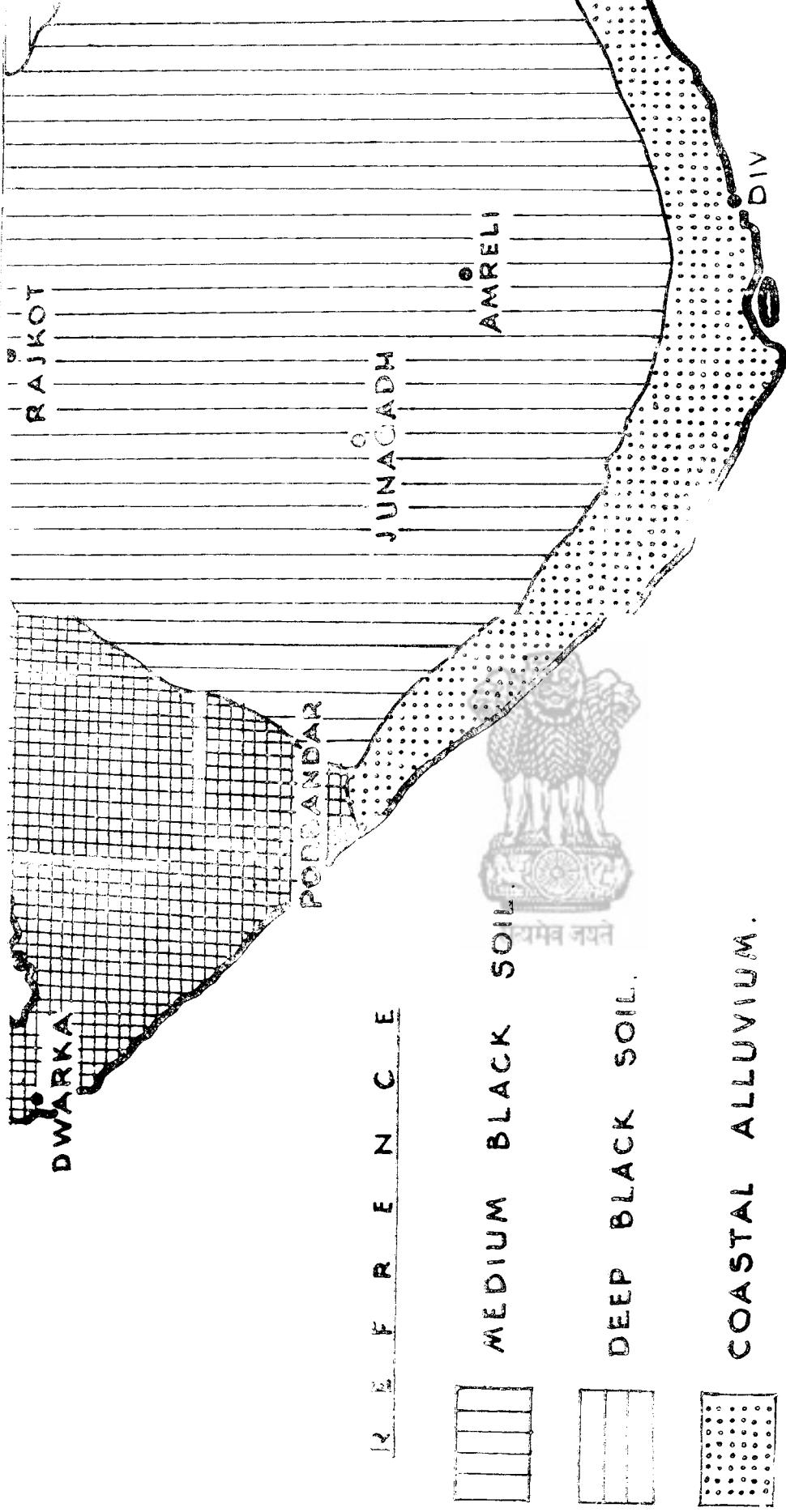
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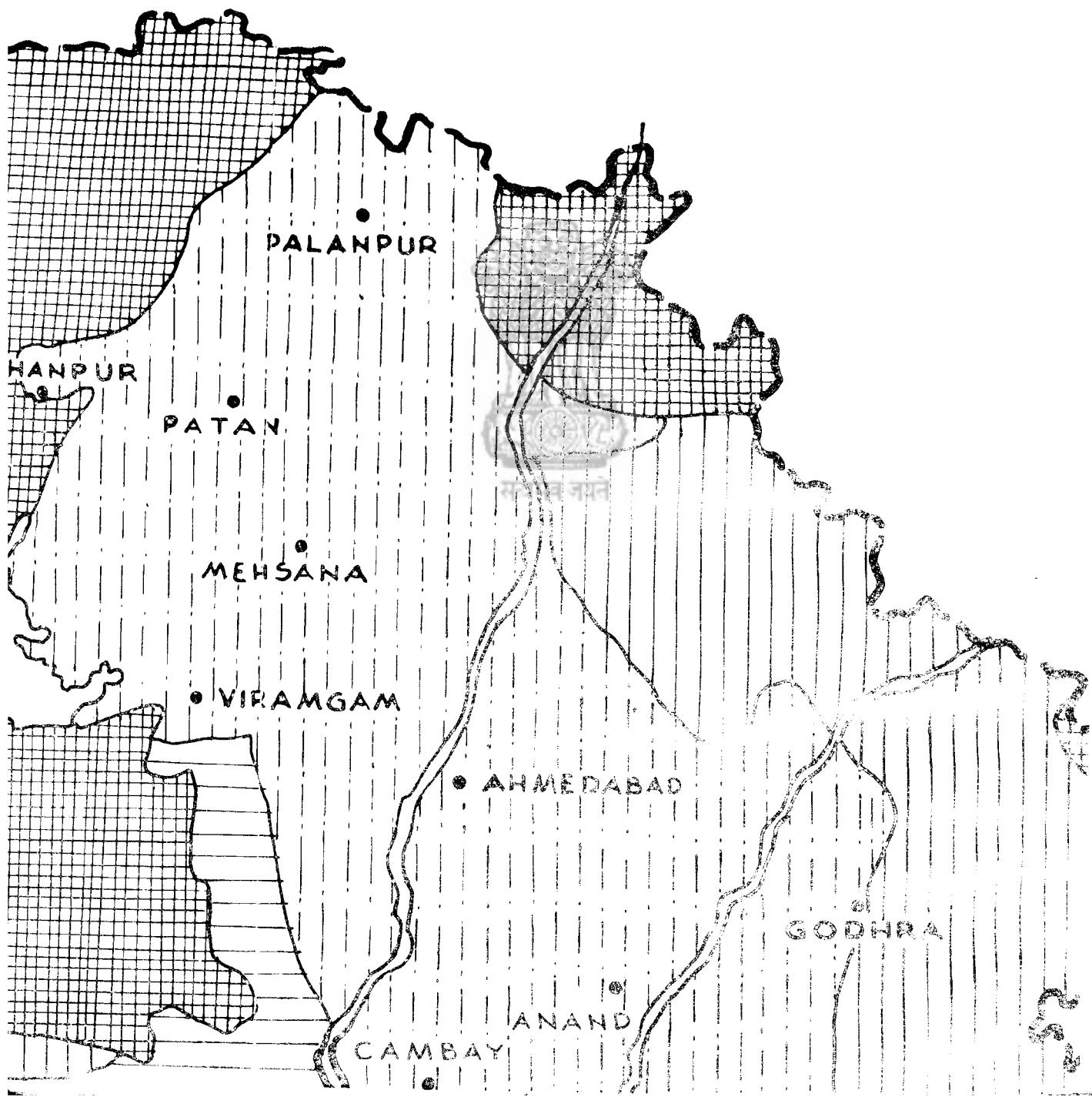


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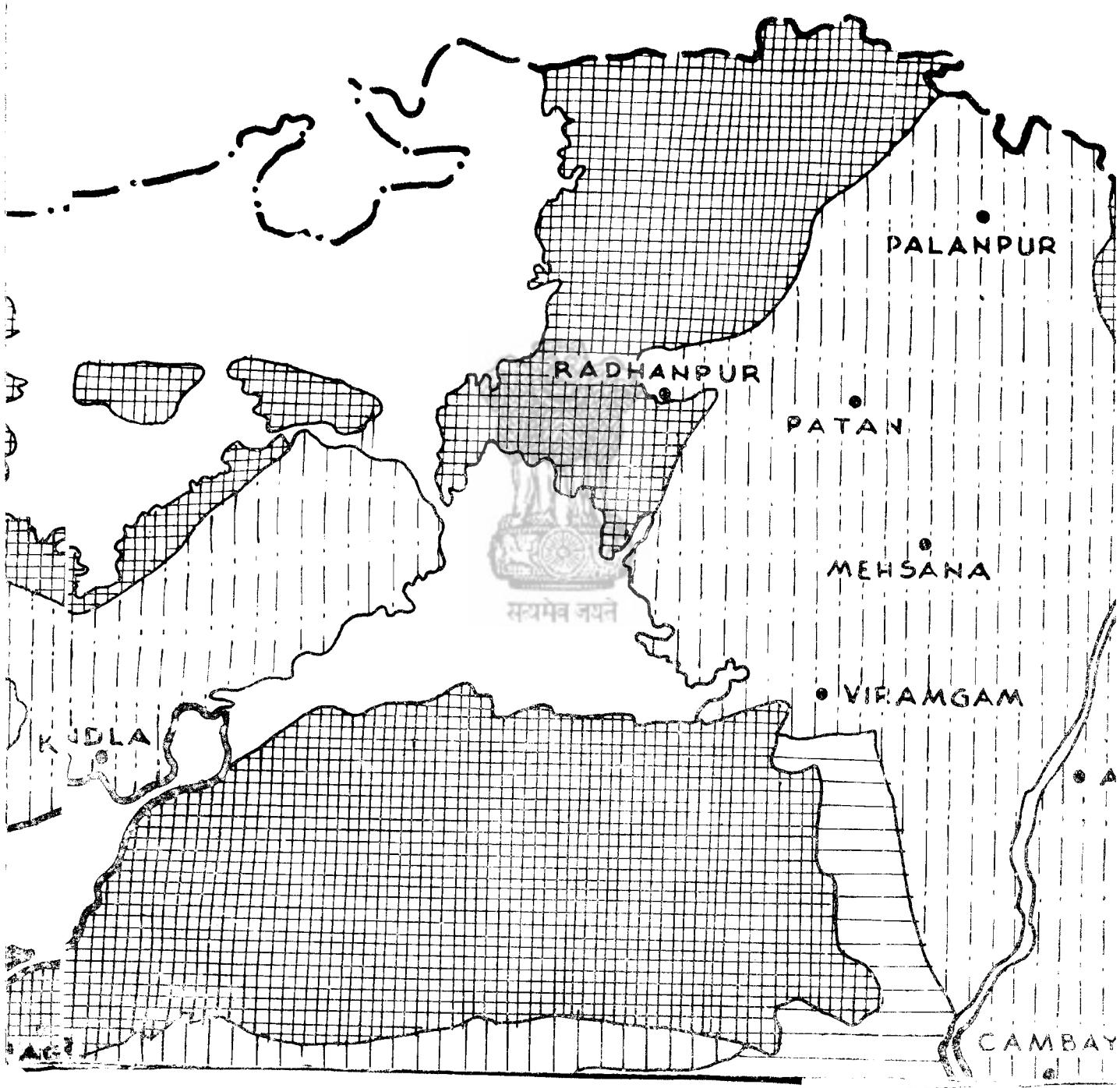
Scale: 1" = 22 mil



STATE



GUJARAT STATE



८



RC : १२३

MAP OF BROACH AND ANKLESVAR

AND HANSOT MAHAL [^]

SCALE:- 2 MILES TO AN INCH

REFERENCE

RAILWAY ----- +-----

NATIONAL HIGH WAY ----- +-----

STATE HIGH WAY ----- ==

RIVER ----- ~~~~~

IMPORTANT VILLAGES ... ○

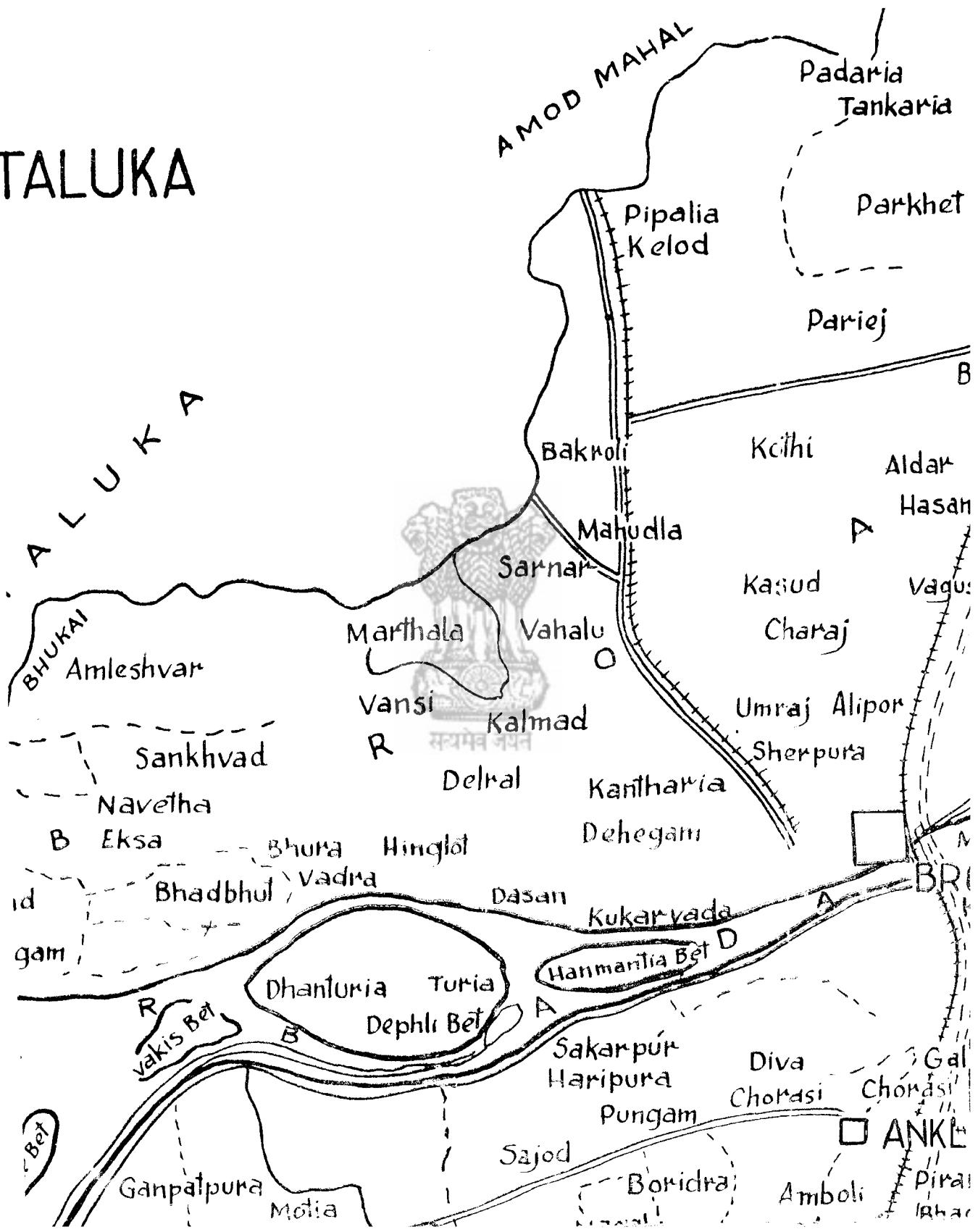


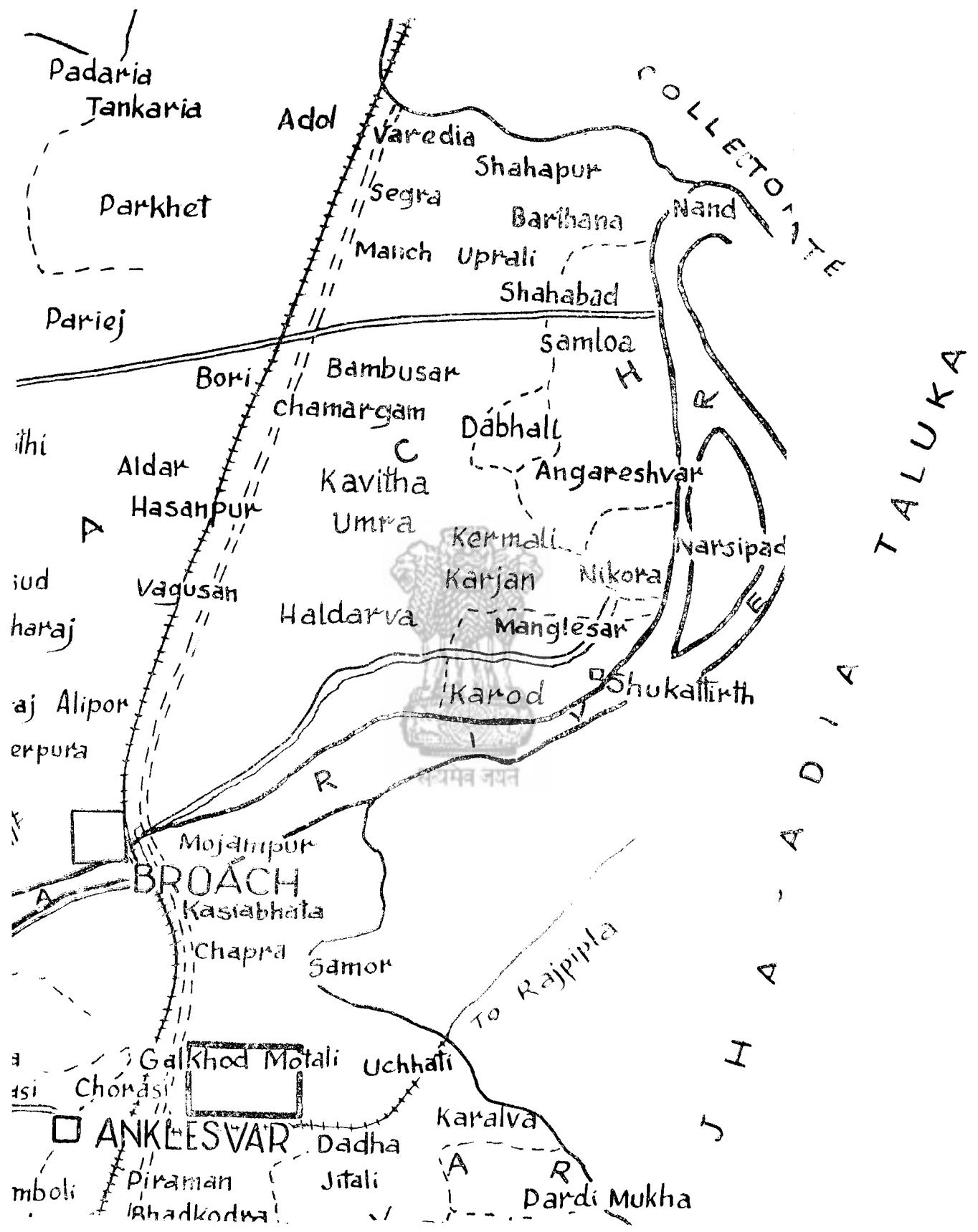
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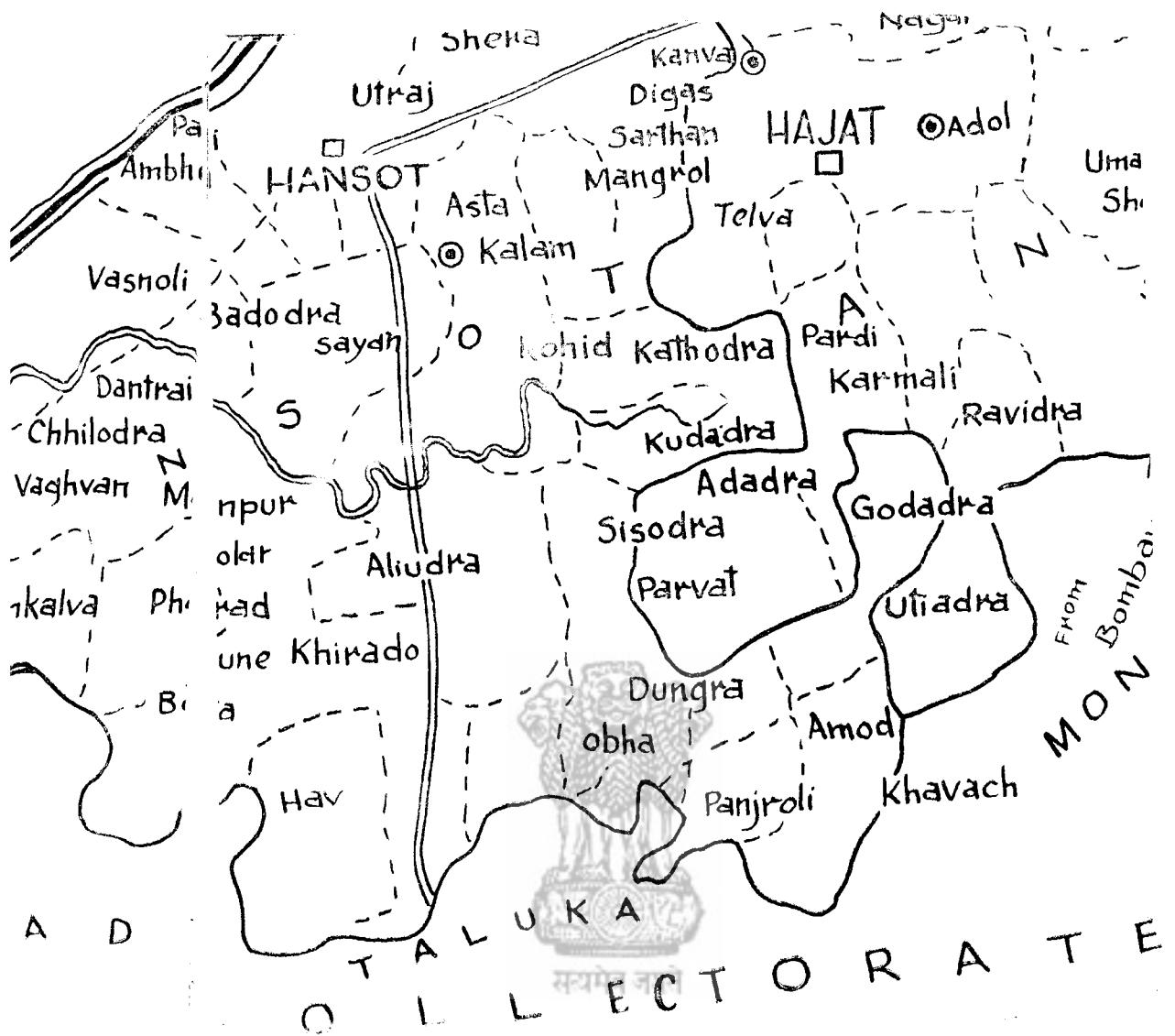
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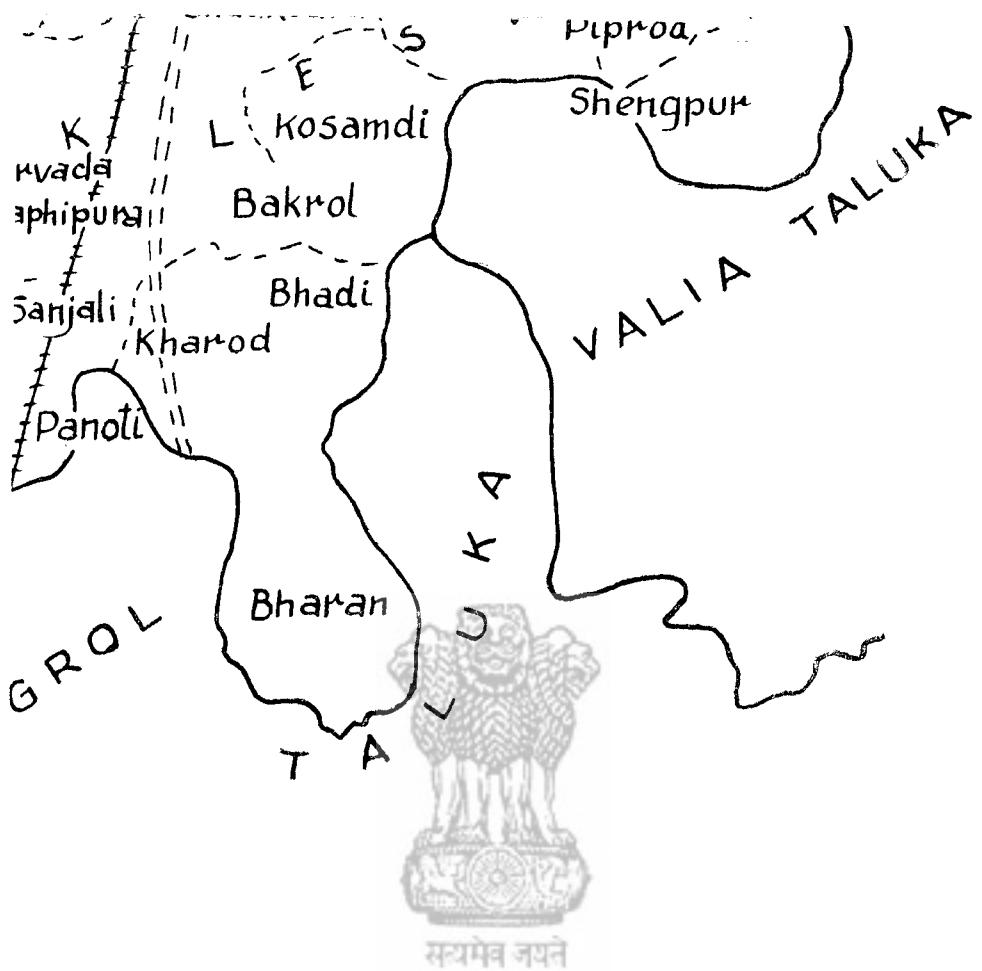
TALUKA

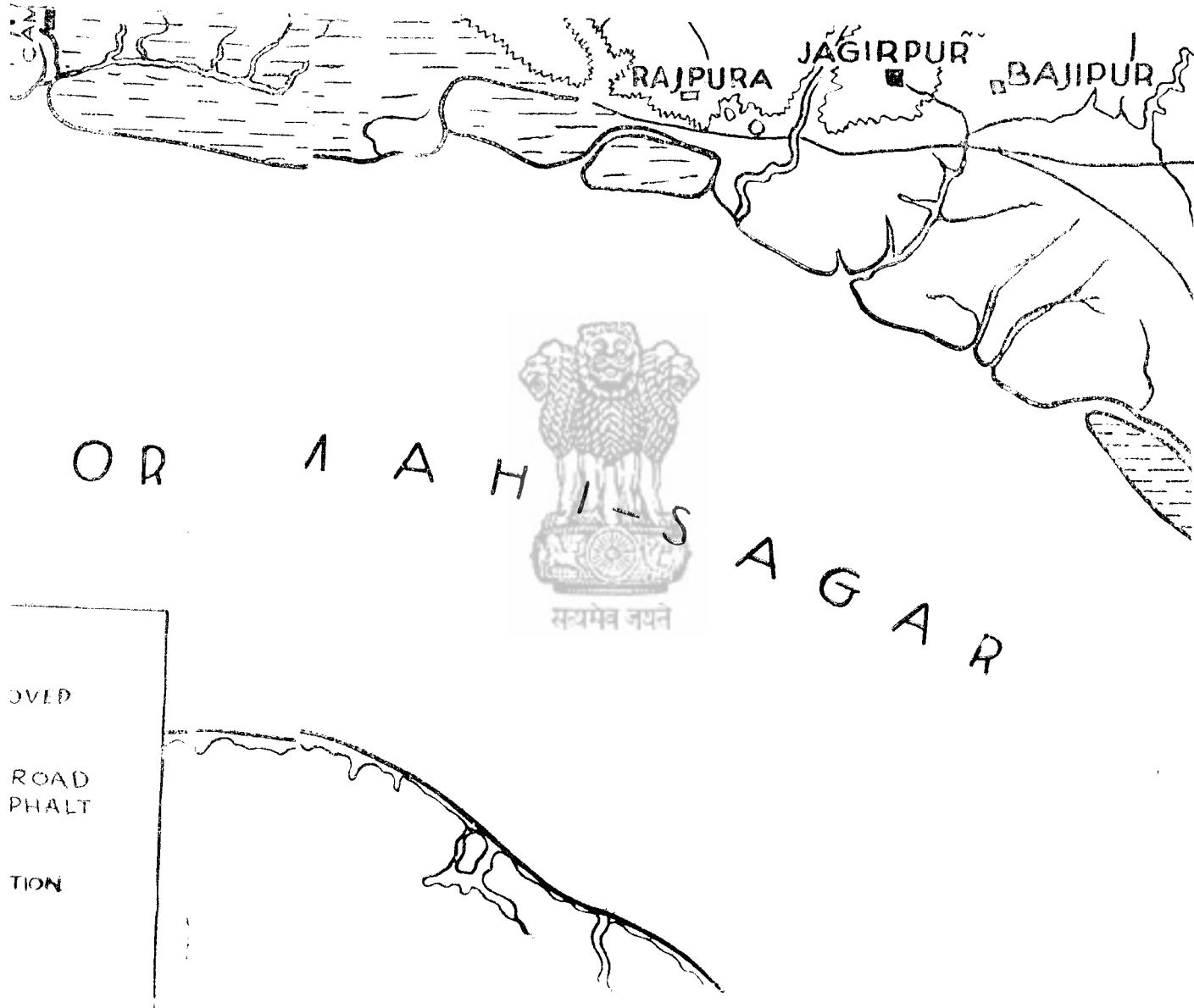


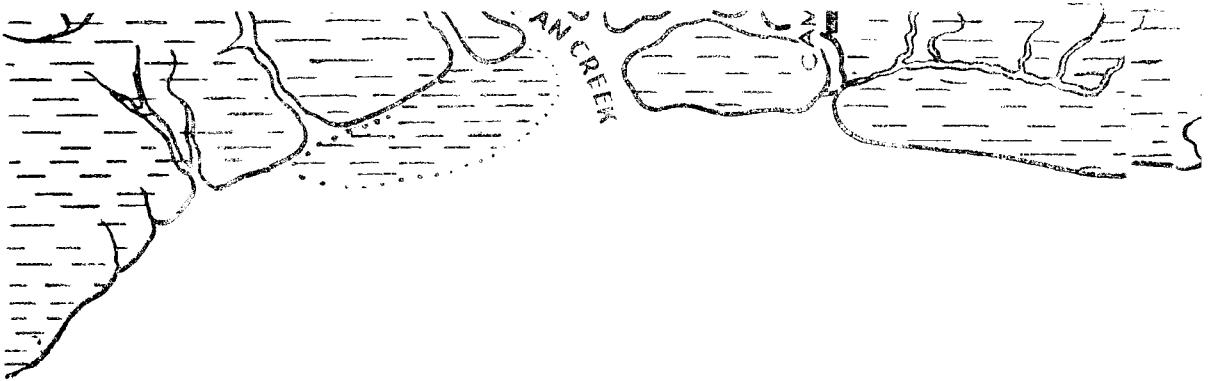








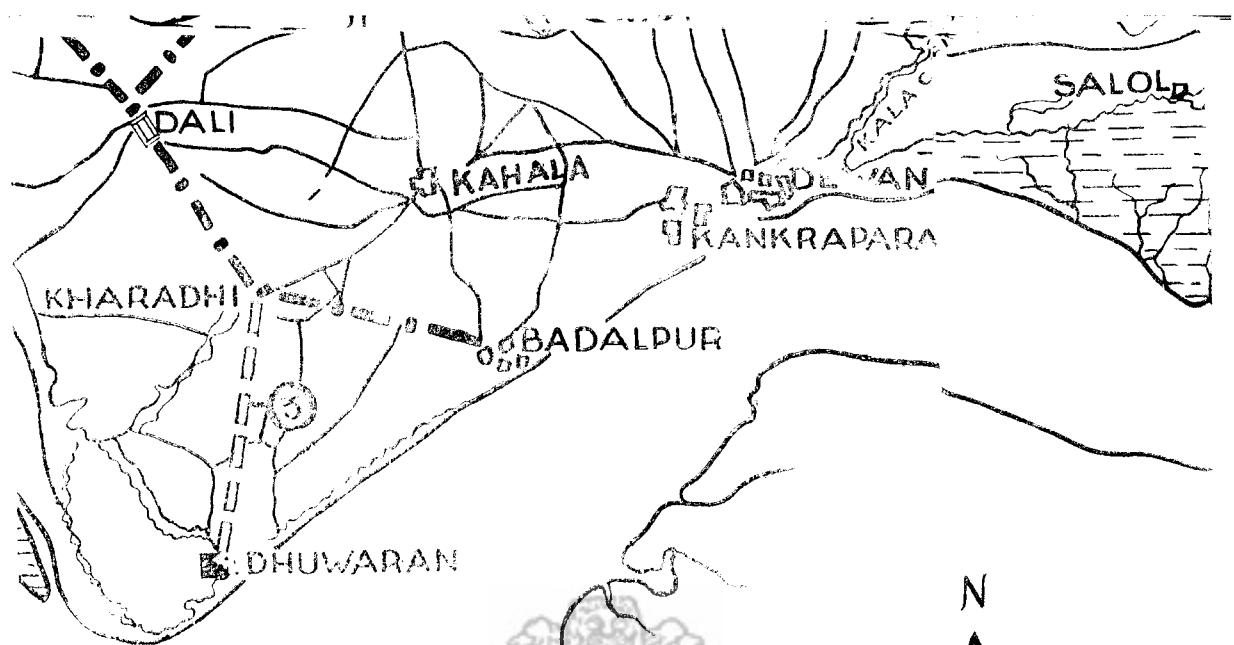




M A H I O R

NOTE:-

- ① BORSAD DALI ROAD, O.D.R.
EXISTING KANKAR ROAD TO BE IMPROVED
WITH METAL AND ASPHALT CARPET.
- ② KANSARI UNDEL KALAMSAR BADALPUR ROAD
O.D.R. TO BE RECONSTRUCTED AS ON ASPHALT
ROAD.
- ③ APPROACH ROAD TO THERMOL POWER STATION
TO BE CONSTRUCTED AS ASPHALT ROAD.

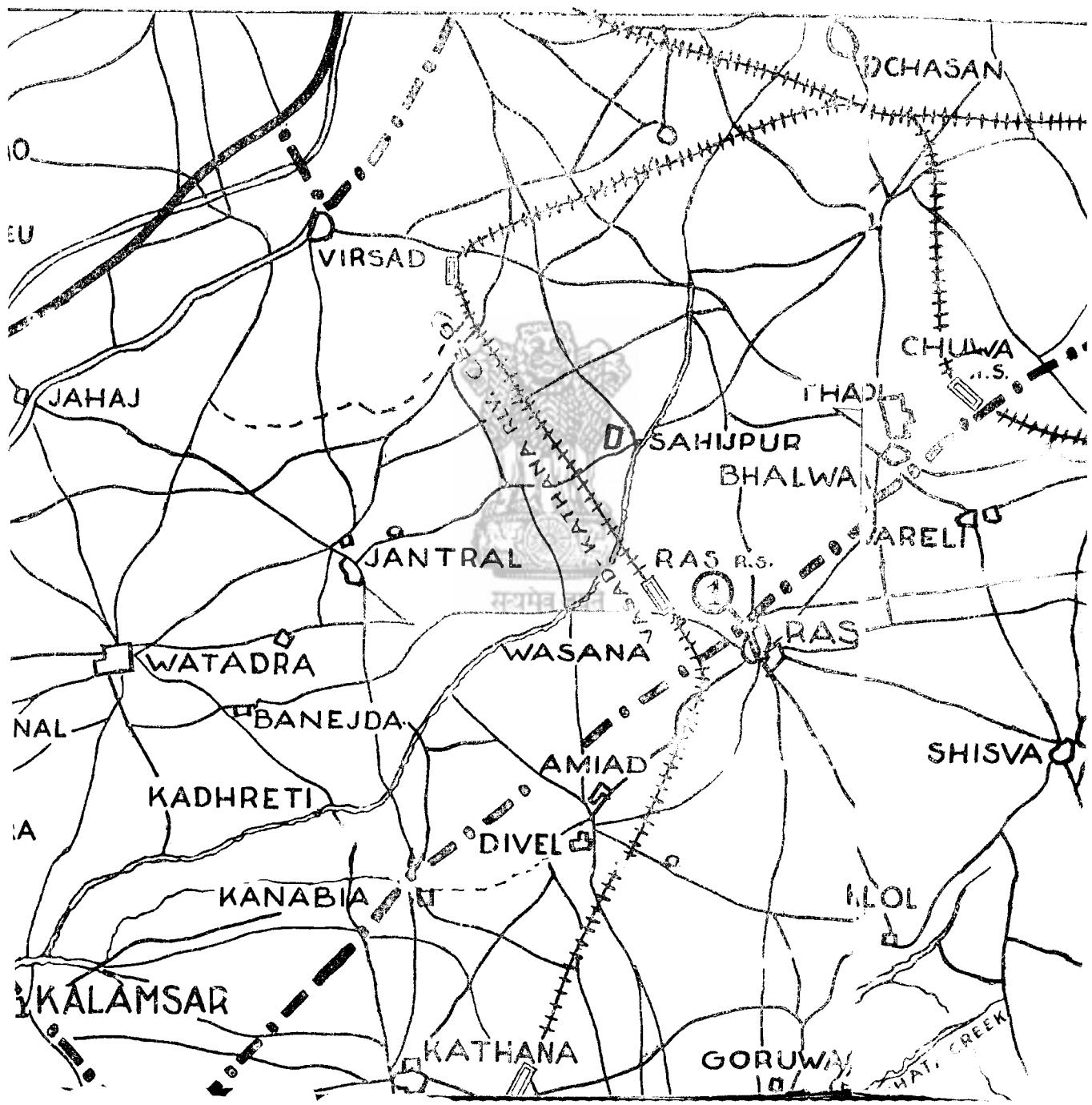


I V E R

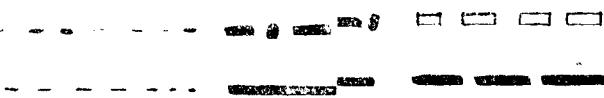


THE DEVELOPMENT IN THE AREA NEAR ABOUT CAMBAY

SCALE - 1 MILE TO 1 INCH

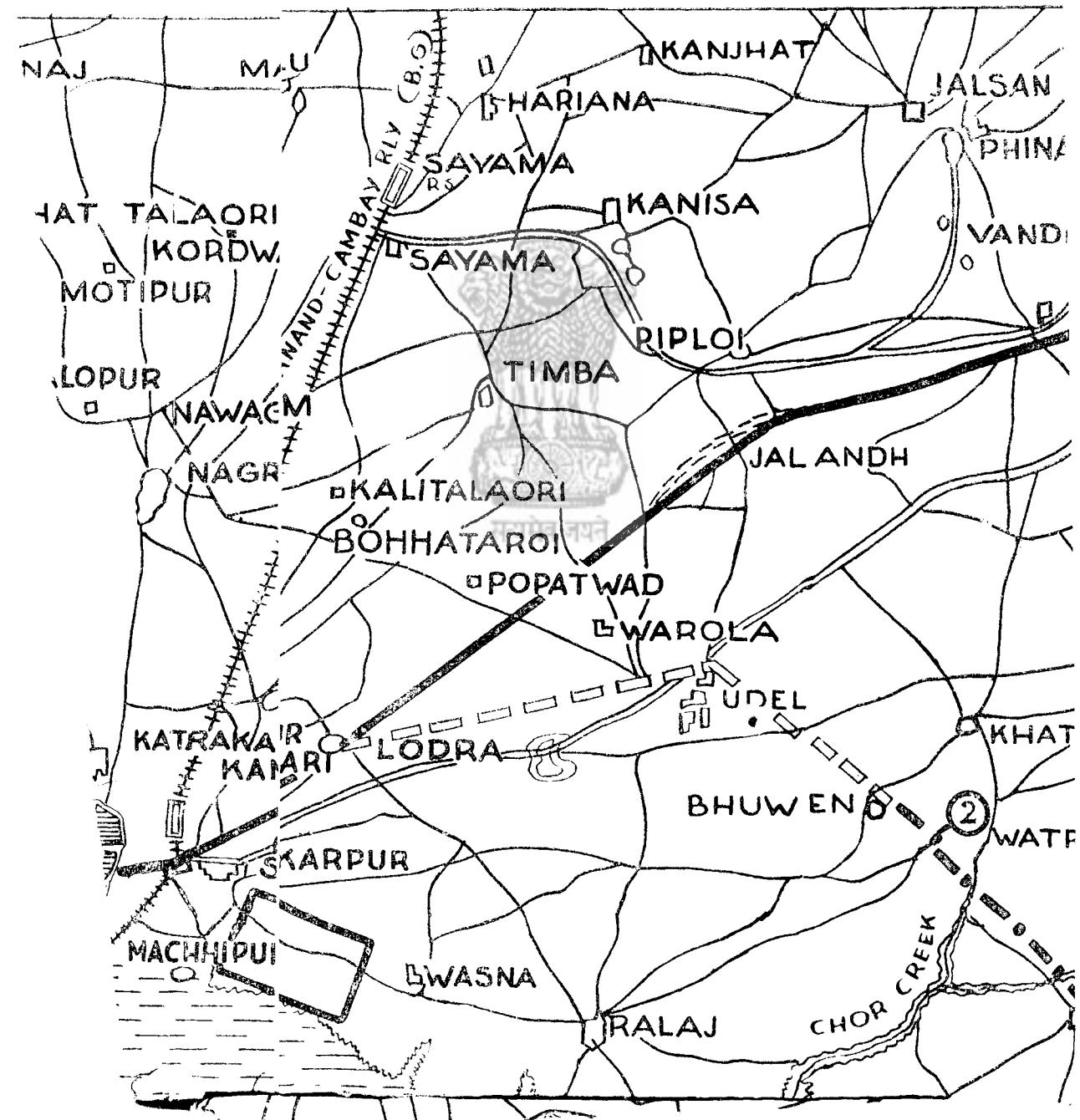


EXISTING IN PROGRESS PROPOSED



NS ----- (e)

N AT DHUWARA



LEGEND

- 1 KATCHA ROADS -----
- 2 PACCA ROADS - - - - -
- 3 DRILL SITES LOCATIONS ---
- 4 PROPOSED THERMAL POWER STN AT D

